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Project Director: Dr. Ward O. Winer

Sponsor: Dow Corning Corporation

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GEORGIA INSTITUTE OF TECHNOLOGY
School of Mechanical Engineering
Atlanta, Georgia

# Investigations of the Rheology of a Series of Silicones as Related to Elastohydrodynamic Lubrication

By

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Graduate Student

D. M. Sanborn
Assistant Professor

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Dow Corning Corporation
Midland, Michigan 48640

November 1972

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C. Reprints of: Sanborn, D. M. and Winer, W. O., "Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts with Transient Loading: I - Film Thickness," Journal of Lubrication Technology, Trans. ASME, 93, 1971, pp. 262-271; and Sanborn, D. M. and Winer, W. O., "Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts with Transient Loading: II - Traction," Journal of Lubrication Technology, Trans. ASME, 93, 1971, pp. 342-348.

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## I. Introduction

This report is a summary of the research performed under the Dow Corning Research Fellowship in Mechanical Engineering at the Georgia Institute of Technology from January to December, 1971. The pressure-viscosity characteristics and elastohydrodynamic (EHD) behavior of a series of silicone fluids were determined.

The report also includes for comparison pressure-viscosity characteristics of silicone fluids as measured by Bridgman (1,2) and Novak and Winer (3,4), and elastohydrodynamic lubrication characteristics of two silicones as measured by Sanborn and Winer (5,6).

## II. Experimental Fluids

The experimental fluids were provided by the Dow Corning Corporation and are listed in Table I. Appendix A contains copies of all correspondence with Dow Corning personnel regarding these fluids. The fluids consist of three groups: (a) octylmethyl siloxanes of varying degrees of polymerization (DP) (fluids E-1318-88-1,3,4,9,10), (b) fluids for which the degree of polymerization was 35 Si-O groups (DP-35) with varying alkyl-methyl side radicals (fluids E-1318-88-2,5,6,7, 8,9,11,12*) and (c) phenylmethyl siloxane fluids of two different phenyl contents (E-1318-88-13,14). Fluids E-1318-88-1 through 10 were specifically synthesized for this study, while fluids E-1318-88-11,12,13,14 were standard production fluids. Fluid 11 was the same as the fluid used as a base for synthesizing fluids 1-10**. Of those listed in Table I, neither pressure viscosity nor elastohydrodynamic (EHD) data were obtained for material 5 which was a solid at room temperature and atmospheric pressure. Elastohydrodynamic lubrication data was not obtained on the methylhydrogen siloxane, 11, because an elastohydrodynamic lubrication film could not be generated under any of the operating conditions available in the apparatus. This included experiments at contact loads of less than 2 pounds and sliding velocities of over 180 in/sec.

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*Although fluid E-1318-88-12 was originally labeled DP-35 it was later found by Dow Corning personnel to be closer to DP-43.

**The fluids will be referred to by the last digits of the Dow Corning book number because the first part of this designation (E-1318-88) is common to all experimental fluids in this study.

The chemical composition of each fluid was determined by Dow Corning personnel. The only fluid questioned by us was 7, which did not exhibit viscosity behavior as expected when compared to the remainder of the DP-35 series. Upon subsequent examination by Dow Corning personnel it was found to have three percent unreacted $C_{14}H_{28}$ remaining from the synthesizing process (see Appendix A) which is expected to significantly reduce the viscosity.

## III. Experimental Procedures

### A. Pressure-Viscosity Measurements

The pressure-viscosity data were taken in a high-pressure capillary type viscometer available in this laboratory which has been described in detail in the literature (3,4). A reprint of reference (4) is attached as Appendix B, and reference (3) was supplied to Dow Corning previously because the work described in it was in part supported by previous Dow Corning Fellowship Grants.

Pressure-viscosity data were taken at three temperatures (100, 210, 300F) from atmospheric to some upper limit in pressure. The upper pressure limit was determined by either (a) maximum pressure limit of the instrument (≈100,000 psi), (b) maximum viscosity limit of the instrument ($\approx 10^5$cp), or (c) apparent solidification of the material. Limitations (a) and (b) are discussed in reference (4) (Appendix B), and limitation (c) only applies to fluid 7 which will be discussed in Section V of this report.

The above pressure-viscosity data were all taken at relatively low shear rates and shear stresses ($\leq 10^4$dynes/cm$^2$) where, in general, the viscosity did not exhibit dependence on shear rate. In addition to that data, measurements were also made at 100F and 10kpsi and 20kpsi as a function of shear stress up to the maximum shear stress capability of the instrument. These determinations were made to assess the shear thinning behavior of the materials. The upper limit of shear stress was typically 2 x $10^6$ dynes/$cm^2$. For fluid 12 these measurements were also made at 30 and 50kpsi.

The atmospheric pressure viscosities were measured with calibrated routine glass capillary viscometers according to ASTM specification D-445-65. The densities required to convert the measured kinematic viscosities to absolute viscosities at atmospheric pressure were measured in pycnometers calibrated by the method described for ASTM method D 1217-54. These viscosities and densities are shown in Table II.

B. Elastohydrodynamic Lubrication (EHD) Measurements

The EHD data were taken in an EHD simulator consisting of a steel sphere rotating and loaded against a sapphire plate. This apparatus has been described in detail in the literature (5,6). Reprints of references (5,6) are attached as Appendix C.

The data taken in the EHD simulator were at 75F, maximum Hertz pressure of 150,000 psi (15 pound normal load) and at sliding speeds of 13.7 and 27.4 in/sec (relative velocities of the two surfaces between which the fluid is acting as a lubricant). These data consisted of center and minimum film thickness values in the contact area and the traction force tramsmitted through the fluid film from one surface to the other. The traction data are reported as a traction coefficient (TC), which is the traction force divided by the normal load applied to the contact (similar to a coefficient of friction). The refractive index of each fluid was measured in an Abbe Refractor at 75F with white light and is reported in Table II.

# IV. Experimental Results

## A. Pressure-Viscosity Measurements

The experimental pressure viscosity data are presented in several ways. Figures 1-n (n = 1,2,---14 depending on the fluid - see Table I) consist of the isothermal (100, 210, 300F) log viscosity-pressure data. Figures 2-n contain the Roelands (7) plots of the viscosity-pressure isotherms. Figures 3-n consist of plots of viscosity versus shear stress at the designated pressure and temperature. Figures 3-n give an indication of the extent of pseudo-plastic, or shear thinning, behavior of the fluid. A computer printout of all the pressure-viscosity data including summary tables of averaged data is presented in Appendix D.

The fluids can be divided into three categories: 1) the octylmethyls, 2) the DP-35 fluids, and 3) the remainder of the group supplied. Figure 4 (a,b,c) displays the reduced viscosity ($\mu(p)/\mu_0$) pressure isotherms for the octylmethyl fluids at 100, 210, and 300F respectively. Figure 5 (a,b,c) and Figure 6 (a,b,c) are similar to Figure 4 but for the DP-35 fluids and fluids 9,11,13,14,7,J respectively. Figures 4 and 5 are almost identical as seen from fluid 9 which is on each figure for comparison. It is clear from these data that neither the degree of polymerization nor the size of the alkyl side radical influence the low shear rate reduced viscosity pressure behavior even though they do influence the viscosity level, viscosity-temperature dependence, and viscosity-shear dependence.

In elastohydrodynamic lubrication the pressure viscosity characteristics are important. However, there is little agreement on a method of expressing this characteristic in a concise and meaningful fashion. There are several methods available, two of which are defined in Figure 7. Traditionally the slope of the tangent to the log viscosity vs pressure curve at atmospheric pressure has been used ($\alpha_{OT}$). However, there is an increasing interest in $\alpha^*$. We tend to prefer the latter since it takes the entire pressure-viscosity curve into account. A third method which uses the Roelands slope index Z is also used for fluid comparison purposes but has not been used analytically in EHD correlations or studies. Roelands correlation is discussed in detail below. Table III contains these three pressure-viscosity parameters at each temperature for the fluids examined. Figures 8 and 9 contain Z and $\alpha^*$ respectively as functions of degree of polymerization.

The pressure viscosity coefficients, $\alpha_{OT}$ and $\alpha^*$, are functions of temperature. We have found empirically that a good relationship between temperature and $\alpha$ is the $\ln \alpha$ vs T relationship. Figure 10 (a,b) contains plots of $\ln \alpha_{OT}$ and $\ln \alpha^*$ vs T respectively. Figure 10c contains Z vs T.

Roelands (7) empirical pressure-temperature-viscosity correlations have been found to be quite useful for a wide range of fluids for interpolating data. The viscosity-pressure plots in terms of Roelands correlations are shown in Figure 2-n. Roelands correlation in simplified form can be written as

$$\frac{\log \eta + 1.200}{\log \eta_{o,r} + 1.200} = \left[\frac{T_r + A}{T + A}\right]^{S_o} \left[1 + \frac{P}{B}\right]^{Z_r}$$

where

$\eta$ = viscosity, cp

$\eta_{o,r}$ = viscosity, cp at atmospheric pressure and $T_r$

$T$ = temperature

$T_r$ = reference temperature, same dimensions as T

$P$ = pressure

$S_o$ = temperature - viscosity slope index at atmospheric pressure

$Z_r$ = pressure - viscosity slope index at $T_r$

$A$ = constant = 135 if T [C]
= 211 if T [F]

$B$ = constant = 2000 if p [kgmf/cm$^2$]
= 28,440 if p [lbf/in$^2$]

The ability of this correlation to predict actual viscosity data decreases at higher pressures (>30-40 kpsi). The divergence between the correlation and actual data can be assessed by the deviation from a straight line of the isotherms on the Roelands viscosity-pressure plots, Figures 2-n.

The values of the pressure-viscosity slopes Z at each temperature where measurements were made are shown in Table IIIc and plotted in Figure 10c. The parameter Z is the actual slope of the isotherm on the Roelands plots shown in Figure 2-n. It is clear from Table IIIc and Figure 10c that the values of Z are not, in general, constants independent of temperature as Roelands suggests. The values of $S_o$, the atmospheric viscosity temperature slope index, have also been calculated and are shown in Table IV.

B. Elastohydrodynamic Lubrication Measurements (EHD)

The centerline and minimum film thickness data, in addition to the traction coefficients for all but two of the fluids supplied are shown in Table V. Fluid 5 was a solid and, therefore, could not be evaluated with the available apparatus. Fluid 11 did not produce an EHD film under any of the test conditions. In fact, even at very light loads (2 lbs) and high surface velocities (184 ips), conditions which normally produce relatively thick EHD films, the ball surface and Inconel coating on the sapphire were severely scratched. In addition, the traction force recorded was erratic and an order of magnitude greater than that of the other fluids tested which suggests contact between the two solid surfaces.

The centerline film thickness recorded in Table V is the greatest film thickness in the EHD contact and is the approximate film thickness of most of the EHD contact area. The minimum film thickness values are of major importance in wear considerations. In all of the above tests the minimum film thickness was located in the side lobes of the horseshoe shaped constriction characteristic of EHD point contacts (Appendix C). As defined previously, the traction coefficient (TC) refers to the steady-state tractive force transmitted from one bearing surface to the other through the film, divided by the normal load applied to the contact. All three quantities, $h_c$, $h_m$ and TC are shown in Table V and follow trends typical of other fluids which have been investigated. Namely, for a given fluid, an increase in sliding speed (in this case doubling it) results in substantial increases in both the centerline and minimum film thickness, but causes a decrease in the traction coefficient.

Center film thicknesses range from a low of 1μ-in for fluid 1 at 27.4 ips to a high of 31 μ-in for fluid 13 at 27.4 ips. The film thickness resolution of the experimental equipment is about 1μ-in except in the range 0-2μ-in, where the resolution is believed to be less than 0.5 μ-in. This 30 fold increase in film thickness must be attributable to fluid rheology, since all other conditions remained the same. The variation in traction coefficient is not nearly so striking. At 13.7 in/sec, the traction coefficients range from 0.043 for fluid 2 to 0.091 for fluid 14. Similarly, at 27.4 in/sec, the range is from 0.036 for fluids 2 and 7 to 0.082 for fluid 14. The traction therefore appears to be much less dependent on the lubricant rheology.

# V. Discussion of Experimental Results

## A. Pressure-Viscosity Measurements

One of the most interesting findings of the pressure-viscosity investigations is the similarity of viscosity-pressure behavior for all the alkyl methyl siloxanes investigated as seen in Figures 4, 5, 8 and 9. The reduced viscosity ($\mu(p)/\mu_o$) at any temperature is essentially the same for all the octylmethyls independent of DP and all the DP 35 alkyl methyl materials. Although the DP and size of side group influence the viscosity level and the viscosity temperature-dependence, they seem not to influence the viscosity pressure dependence as measured by $\alpha^*$ which is believed to be the most important for EHD behavior of the fluid. Figure 9 displays $\alpha^*$ at 100F as a function of degree of polymerization with type and size of side alkyl radical as additional variables. The data point for fluid 7 should not be weighted heavily because that fluid solidified at about 7 kpsi and, therefore, very little viscosity data at elevated pressure was available. When considering the remainder of the data it is clear that for siloxane molecules with straight alkyl side radicals neither the DP nor the length of the alkyl side radical has much influence on the pressure viscosity characteristic $\alpha^*$, i.e. less than +5% except for fluid 2 which is within 10% of the average, even though their atmospheric viscosities vary by about a factor of 400. If the side group is hydrogen (fluid 11), $\alpha^*$ is less and if the side group is a more rigid and bulky molecule such as a phenyl group (fluids 13 and 14) or a fluorinated propyl (fluid J) the $\alpha^*$ is more than that for the straight alkyl groups on the siloxane chain.

Although empirical in origin the Roelands correlation is quite useful for interpolating pressure-viscosity data over a wide range of temperatures and pressures. The limitations of the Roelands correlation for silicone fluids appear to be similar to those of other fluids. That is at high pressures (above about 40 kpsi for silicones) the measured viscosities are greater than the predicted viscosities and the divergence between the two increases with increasing pressure (see Figure 2-12). Also as temperatures are increased, or viscosity decreased, the viscosity-pressure isotherm tends to deviate from a straight line, resulting in a decreasing dependence of viscosity on pressure as pressure is increased (see Figure 2-12) in the low pressure range.

In the Roelands correlation the viscosity-pressure slope index Z and the viscosity-temperature slope index S are expected to be constant for a given fluid. However, from Figure 10c it is seen that for some fluids (namely 13, 14) the index Z varies considerably with temperature. Upon examining the Roelands pressure-viscosity plots (Figures 2-n) the variation of Z for fluids 13 and 14 can be seen to be the result of a much greater increase of viscosity with pressure of the fluids at 100F than at the higher temperatures. That is, the rate of increase of viscosity with pressure of these fluids decreases considerably as temperature is increased.

When considering the viscosity-pressure dependence as measured by $\alpha_{OT}$ and $\alpha^*$ (Figure 10a,b) we see that fluids 13 and 14 have greater values of $\alpha_{OT}$ and $\alpha^*$ at 100F than the other fluids, but at 210 and 300F they are similar to the other fluids. Because EHD film thickness is dependent on the pressure-viscosity variation of the fluids, we would expect a greater film thickness for comparable viscosity level from fluids 13 and 14 at 100F. This is shown to be the case elsewhere in this report where EHD data at 75F for fluids 13 and 14 show relatively thick films. These thick films for fluids 13 and 14 relative to the others would not be expected at higher temperatures such as 210F to 300F.

The decrease of viscosity with increasing shear stress as shown in Figure 3 can be the result of pseudoplastic shear thinning (non-Newtonian behavior) or viscous heating in the capillary at high shear stress resulting in a viscosity decrease because of local temperature increases. The separation of these two effects is the subject of another research program in this laboratory. On the basis of what we have learned thus far we believe that the viscosity decreases observed for fluids 1, 3, 11, 12, 13, 14 are probably the result of viscous heating, for fluids 4 and 10 are partly viscous heating and partly pseudoplastic, while the others are primarily pseudoplastic shear thinning. This is consistant with the commonly accepted idea that pseudoplasticity or shear thinning is associated with longer molecules (larger DP) and longer side groups.

The temperature viscosity behavior as measured by Roelands slope index S appears (Figure 8) to increase with decreasing DP below a DP of 25 and only varies ±10% for all side groups at a DP of 35. This measure is somewhat misleading, however, because of the nature of Roelands correlation. If the viscosity temperature variation were measured by the more traditional logrithmic derivative of the viscosity with respect to temperature, we would find that fluid 1 has the smallest change of viscosity with temperature and that the logrithmic derivative of viscosity increases with the log of the viscosity.

Finally a comment is in order on the solidification of fluid 7 in the pressure viscometer at about 7 kpsi. This was the only fluid to solidify at any of the pressures employed in the pressure-viscometer. Fluid 7 has $C_{14}H_{29}$ side groups while its neighboring homolog, fluid 5, had $C_{16}H_{33}$ side groups and was a solid at room temperature and atmospheric pressure. It is not surprising then that fluid 7 solidified under pressure at only 7 kpsi. However, it is interesting to note that in the EHD simulation where pressures exceeded 150 kpsi for only a short period of time, fluid 7 behaved in no way differently from the other fluids which did not solidify. The solidification is of course a time dependent phenomena, and solidification did not have time to occur in the EHD simulator, but did have time to occur in the pressure viscometer. This is the only clear demonstration we are aware of which indicates that the equilibrium solidification occurring in viscometery of many fluids does not occur in the EHD short time situation. The fluid in the EHD contact is obviously in a non-equilibrium super-cooled state.

B. Elastohydrodynamic Lubrication Measurements

It is quite common in the study of EHD contacts (Appendix C) to express a centerline film thickness dimensionless parameter $H_c^* = h_c/R$ (where R=0.625" is the equivalent radius of curvature of the system and $h_c$ the film thickness at the contact center) as a function of a combined speed and materials parameter $\overset{**}{UG} = \eta U\alpha^*/R$ (where U is the sliding velocity and $\eta$ the low shear rate atmospheric pressure viscosity at the temperature of the fluid entering the conjunction). A plot of $H_c^*$ vs UG is shown in Figure 11. According to the current analytical investigations (8), this film thickness parameter should be proportional to the combined speed-material parameter $\overset{**}{UG}$ to approximately the 0.6 power. Since the experimental data obviously does not lie along a single line of slope 0.6 as in Figure 11, either the experimental data or the theoretical film thickness predictions must be suspect. The wide scatter shown in Figure 11, however, is typical of other film thickness data obtained in this laboratory. The minimum film thickness parameter $H_m^* = h_m/R$, in fact, shows even more deviation from the 0.6 power law relationship. It is felt that the film thickness data is correct within the resolution specified above. The scatter could be reduced substantially, however, if the viscosity used in calculating $\overset{**}{UG}$ were a viscosity representative of the EHD contact inlet conditions instead of the viscosity of the lubricant evaluated at atmospheric pressure, low shear rate, and ambient temperature. This effective contact inlet viscosity should reflect the shear rate in the contact inlet ($\sim 10^7 sec^{-1}$) and an appropriate inlet temperature. The quantity $\alpha^*$, also included in $\overset{**}{UG}$, characterizes the pressure-viscosity increase in the contact inlet. Work is currently being carried out in this laboratory to measure the viscosity of lubricants at shear rates on the order of $10^7 sec^{-1}$ and to map the temperature profile in the contact and, therefore, we expect to be able to account for a thermal reduction in the contact inlet viscosity. We are not yet in a position to make a reasonable estimate of the effective viscosities for these fluids.

However for a given fluid in Figure 11 the slope is 0.6 within the accuracy of the film thickness measurements. The fact that all the data is not on a single line suggests that some phenomena not accounted for in the theories is occurring. Since the loads and therefore probably pressure distributions are all about the same, the speeds nearly the same, and for all but 13, 14 and J, the $\alpha^*$'s about the same, it is likely that the lack of correlation is related to the viscosity values used in $\overset{**}{UG}$. Since the shear rate in the EHD inlet region is about $10^7 sec^{-1}$, shear thinning or viscous heating are the most likely explanations. If we use Figures 3 to estimate the amount of shear thinning for each fluid at $10^7 sec^{-1}$ shear rate, all the data in Figure 11 would tend to move to the left to a single line suggesting that pseudoplasticity will explain a great deal of the spread in the data of Figure 11.

The difference between the two dimethyl fluids, I and 12 cannot be explained solely in terms of measurement accuracy. Fluid I has twice the low shear atmospheric pressure viscosity that fluid 12 has at 77F. Therefore one would expect the EHD film thickness to be greater for I than for 12, other things being equal. Because these fluids have the smallest film thickness, they are subjected to the highest shear rates ($\approx 2 \times 10^7$ $sec^{-1}$). It is possible that different blending techniques were used in making up these two fluids and that at the high shear rates the effective viscosity of I is less than that of 12. Between the experimental error in film thickness and the possible shear thinning of fluid I, the relative behavior of fluids I and 12 shown in Figure 11 might be explained.

The inability to generate an EHD film with fluid 11 (methylhydrogen) cannot be explained on the basis of its very low $\alpha^*$ and $\eta_o$. As seen in Figure 11 the important parameter for the fluid is $\overset{**}{UG}$ and at a sliding speed of 13.7 ips the value of $\overset{**}{UG}$ for fluid 11 is $0.6 \times 10^{-8}$. Attempts to generate an EHD film with fluid 11 were unsuccessful up to sliding velocities of 180 ips where $\overset{**}{UG}$ would be $8 \times 10^{-8}$. As seen from Figure 11 this should have been adequate to generate films of from 3 to 10 microinches and is comparable to the $\overset{**}{UG}$ parameter for fluid 14 at 13 ips sliding speed. Even reducing the load on the contact from 15 to 2 lb at 180 ips sliding speed, which should have increased the film thickness, did not result in an EHD film being formed with fluid 11. This unusual behavior with fluid 11 can not be explained at present. Fortunately fluid 11 is not considered a candidate fluid in lubrication applications anyway.

Figure 12 shows a plot of traction coefficient as a function of centerline film thickness. The high traction, low film thickness data point for each fluid refers to the 13.7 ips sliding velocity, whereas the other data point for the same fluid refers to the 27.4 ips condition. For fluids I and J each data point from left to right represents a doubling of velocity. The primary purpose of Figure 12 is to graphically show which fluids are best suited for surface protection (relatively high $h_c$) when viscous losses are to be minimized, such as in rolling element bearings, cams and gears. Figure 12 also shows which fluids would be more suitable for viscous drive applications where in addition to surface protection, a high traction coefficient is also desired. It is interesting to note that all of the octylmethyl fluids (1, 3, 4, 9, 10) have very similar traction coefficients even though the film thickness varies by a factor of 15 at the same sliding velocity. It is also interesting that, except for fluids 11 and 12 (having considerably lower viscosities than the others), the DP-35 fluids (2,6,7,8,9,11,12) have approximately the same film thickness and traction values. Two fluids which appear to be unique in Figure 12 are 13 and 14. Although their viscosities are substantially lower than the average of the fluids tested, the film thicknesses and traction coefficients are well above average.

Traction coefficients might be expected to be related to an effective viscosity in the contact region. Since the average contact pressures are the same for all the data (≈100 kpsi) and the average shear rates in the contact range from $1 \times 10^6$ to $25 \times 10^6$ $sec^{-1}$, the viscosity at 100 kpsi projected from the viscosity pressure data should establish the order of the traction coefficients. On this basis the order of TC is correct, but dependence of TC on projected viscosity is very insensitive. In the same film thickness range, the TC for 13 and 14 is about twice that of the other fluids but the projected viscosities of fluids 13 and 14 are $10^6$ to $10^7$ times those of the other fluids. Fluids 2,4,6, 7,8,9,10,J all have about the same traction coefficients and their projected viscosities at 100 kpsi differ by $10^2$. It is possible that the TC are limited by viscous heating in the contact and by mechanical degradation. Both of these possibilities are being investigated in our laboratory.

Elastohydrodynamic bearing contacts are characterized by extremely high lubricant shear rates and instantaneous viscosities orders of magnitude higher than the atmospheric pressure values. This combination of high shear rate for a high viscosity fluid results in viscous dissipation rates of extreme magnitude. Two types of analysis have been performed on these fluids. In the first, the energy input rate per unit volume of lubricant in the EHD contact, E, was determined. The calculation is based on the traction force and sliding velocity to obtain the energy input rate. This quantity is then divided by the volume of fluid in the contact, which is determined from the measured film thickness and contact diameter. In the second method, the energy input rate per gmole of fluid flowing through the contact, $\Sigma$, was calculated. Both E and $\Sigma$ are tabulated for each fluid at each of the two sliding velocities in Table VI.

The important point in Table VI is simply the magnitude of E and $\Sigma$. A typical value of $\Sigma = 10^5$kcal/gmole is three orders of magnitude higher than the dissociation energy for the C-H bond. Assuming that most of the $10^5$ kcal/gmole is transferred as heat to the boundaries of the EHD contact, it still appears that mechanical degradation of the lubricant is likely. An experiment is presently underway to determine whether or not there is significant lubricant degradation in EHD contacts.

It appears that the energy input rate E decreases with increasing viscosity, although this is most probably because of the two primary quantities $h_c$ and TC used in computing E, TC varies little while $h_c$ varies by over a factor of 30. The trend in E is, therefore, merely reflecting the variation in film thickness.

## VI. Comparisons with Data in the Literature

There are data in the literature on silicones for both the EHD characteristics (5,6) and pressure viscosity characteristics (3,4 and Bridgman 1,2). Sanborn and Winer (5,6 and Appendix C) report EHD data on a dimethyl siloxane (DC-200-100cs labeled fluid I in this report) similar to fluid 12, and a fluorosilicone (XF1-0294 labeled fluid J in this report). Novak and Winer (3,4 and Appendix B) reported pressure viscosity data on the same two fluids. The data from those publications are included in Figures 8, 9, 10, 11 and 12, Tables I, II, III, IV, V and VI, and Appendix D.

Bridgman (1,2) reported pressure-viscosity data at 77F on series of eight dimethyl silicones (Trimer, Tetramer, Hexamer, Octamer and blends with base viscosities of 1,2, 12,8 and 100 cs each). The pressure viscosity characteristics as described by $\alpha_{OT}$, $\alpha^*$ and Z for these fluids at 77F are shown in Table IIId.

Also shown in Tables III and IV are pressure-viscosity data for a DC-200-500cs fluid measured in this laboratory for Dow Corning but never published.

## VII. Summary

A large amount of pressure viscosity and EHD data were obtained on a series of well defined siloxane fluids. Several conclusions can be drawn from the data.

From the viscosity-pressure measurements it can be concluded that varying the DP or the number of carbon atoms in the alkyl side radical has no effect (less than $\pm 5\%$) on the pressure-viscosity coefficient $\alpha^*$ which is of importance in EHD. The $\alpha^*$ can be increased by adding bulky or rigid side groups such as phenyl or trifluoropropyl to the siloxane chain. Increasing either the DP or the number of carbon atoms in the side group increases the base viscosity, however, as well as the tendency toward increased shear thinning viscosity behavior. This latter behavior is seen from Figures 3-n where fluids 1,3,11,12,13,14 show no shear thinning (the decrease in viscosity seen is believed to be viscous heating), fluids 4 and 10 show a small amount of shear thinning and fluids 2,6,7,8,9 display a large amount of shear thinning. The shear thinning behavior in the viscometer is consistant with the film thickness behavior in the EHD experiments. However because of the large amount of energy dissipated in the EHD contacts it is possible that the shear thinning may be due to irreversible molecular degradation rather than reversible pseudoplastic effects.

From the EHD lubrication viewpoint, when the length of the main siloxane chain (DP) or the length of the side radical are increased the film thickness is not increased in the proportion predicted by EHD theory for the resulting increase in base viscosity. This may be due to a number of mechanisms, but the most likely appears to be the result of pseudoplastic shear thinning which occurs at high shear rates as either DP or length of side chain is increased.

In a highly loaded contact such as in EHD lubrication, the most effective way to increase film thickness or traction coefficient appears to be substituting the alkyl side groups on the siloxane chain with bulky or rigid molecules such as phenyl or trifluoropropyl groups and not by increasing either the DP or the number of carbon atoms in the alkyl side group.

## VIII. References

1. Bridgman, P. W., Proceedings of the American Academy of Arts and Sciences, 77, 1949, pp. 115-128.

2. Bridgman, P. W., Proceedings of the American Academy of Arts and Sciences, 77, 1949, pp. 129-146.

3. Novak, J. D., "An Experimental Investigation of the Combined Effects of Pressure, Temperature, and Shear Stress Upon Viscosity," Doctoral Thesis, University of Michigan, 1968.

4. Novak. J. D. and Winer, W. O., "Some Measurements of High Pressure Lubricant Rheology," Journal of Lubrication Technology, Trans. ASME, 90, 1968, pp. 580-591.

5. Sanborn, D. M. and Winer, W. O., "Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts with Transient Loading: I - Film Thickness," Journal of Lubrication Technology, Transactions ASME, 93, 1971, pp. 262-271.

6. Sanborn, D. M. and Winer, W. O., "Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts with Transient Loading: II - Traction," Journal of Lubrication Technology, Trans. ASME, 93, 1971, pp. 342-348.

7. Roelands, C. J. A., "Correlational Aspects of the Viscosity-Temperature-Pressure Relationship of Lubricating Oils," Doctoral Thesis, Technical University Delft 1966, (also O.P. Books Program, University Microfilm, Ann Arbor, Michigan).

8. Cheng, H. S., "Isothermal Elastohydrodynamic Theory for the Full Range of Pressure-Viscosity Coefficient," Journal of Lubrication Technology, Trans. ASME, 94, 1972, pp. 35-43.

Table I

Experimental Fluids

| Dow Corning Book Number[1] | Description | Degree of Polymerization |
|---|---|---|
| E-1318-88-1 | Octylmethyl siloxane ($C_8H_{17}$-$CH_3$) | 4 to 5 |
| E-1318-88-2 | Dodecylmethyl siloxane ($C_{12}H_{25}$-$CH_3$) | 35 |
| E-1318-88-3 | Octylmethyl siloxane ($C_8H_{17}$-$CH_3$) | 12[2] |
| E-1318-88-4 | Octylmethyl siloxane ($C_8H_{17}$-$CH_3$) | 25[2] |
| E-1318-88-5 | Hexadecylmethyl siloxane ($C_{16}H_{33}$-$CH_3$) | 35 (solid) |
| E-1318-88-6 | Decylmethyl siloxane ($C_{10}H_{21}$-$CH_3$) | 35 |
| E-1318-88-7 | Tetradecylmethyl siloxane ($C_{14}H_{29}$-$CH_3$) | 35 |
| E-1318-88-8 | Hexylmethyl siloxane ($C_6H_{13}$-$CH_3$) | 35 |
| E-1318-88-9 | Octylmethyl siloxane ($C_8H_{17}$-$CH_3$) | 35 |
| E-1318-88-10 | Octylmethyl siloxane ($C_8H_{17}$-$CH_3$) | 20[2] |
| E-1318-88-11 | Methyl hydrogen siloxane (H-$CH_3$)<br>DC 1107 lot #AA-1534 | 35 |
| E-1318-88-12 | Dimethyl ($CH_3$-$CH_3$)<br>DC200-50 cs | 43 |
| E-1318-88-13 | Methyl-phenyl<br>DC710 lot #HH 266 | 12 |
| E-1318-88-14 | Methyl-phenyl<br>DC550 lot #BFO-574 | 18 |
| I | Dimethyl DC-200-100 cs | 70 |
| J | Fluorosilicone XF1-0294 | 30 |

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1. Last number is used for identification in Tables and Figures.

2. DP estimated from log $\mu \simeq \sqrt{\text{Mol.wt.}}$, others obtained from Dow Corning personnel.

Table II

Measured Viscosity, Density and Refractive Index of Experimental Fluids at Atmospheric Pressure

| Fluid | Temp (F) | Viscosity cs | Viscosity cp | Density gm/ml | Refractive Index (White Light) |
|---|---|---|---|---|---|
| 1 | 77 | 25.2 | 22.2 | 0.880 | 1.4366 |
| | 100 | 17.4 | 15.2 | 0.871 | |
| | 210 | 5.01 | 4.15 | 0.829 | |
| | 300 | 2.73 | 2.18 | 0.799 | |
| 2 | 77 | 8856 | 7935 | 0.896 | 1.4554 |
| | 100 | 5282 | 4690 | 0.888 | |
| | 210 | 1026 | 870 | 0.848 | |
| | 300 | 455 | 372 | 0.818 | |
| 3 | 77 | 105 | 94 | 0.895 | 1.4437 |
| | 100 | 62.1 | 55 | 0.886 | |
| | 210 | 15.8 | 13.4 | 0.846 | |
| | 300 | 8.24 | 6.72 | 0.816 | |
| 4 | 77 | 770 | 692 | 0.899 | 1.4481 |
| | 100 | 485 | 433 | 0.891 | |
| | 210 | 100 | 86 | 0.859 | |
| | 300 | 52 | 43 | 0.823 | |
| 5 | No Data | -- | -- | | |
| 6 | 77 | 2390 | 2153 | 0.901 | 1.4524 |
| | 100 | 1467 | 1310 | 0.893 | |
| | 210 | 302.5 | 258 | 0.853 | |
| | 300 | 144 | 118 | 0.818 | |
| 7 | 77 | 3390 | 2983 | 0.880 | 1.4571 |
| | 100 | 2035 | 1775 | 0.872 | |
| | 210 | 384 | 320 | 0.833 | |
| | 300 | 171 | 137.5 | 0.803 | |
| 8 | 77 | 1895 | 1743 | 0.920 | 1.444 |
| | 100 | 1217 | 1110 | 0.912 | |
| | 210 | 299 | 260 | 0.870 | |
| | 300 | 179 | 125 | 0.837 | |

Table II
(continued)

| Fluid | Temp (F) | Viscosity cs | Viscosity cp | Density gm/ml | Refractive Index (White Light) |
|---|---|---|---|---|---|
| 9 | 77 | 1864 | 1683 | 0.903 | 1.4488 |
| | 100 | 1212 | 1085 | 0.895 | |
| | 210 | 274 | 235 | 0.856 | |
| | 300 | 131 | 108 | 0.825 | |
| 10 | 77 | 373 | 337 | 0.904 | 1.4475 |
| | 100 | 239 | 214 | 0.896 | |
| | 210 | 55 | 47 | 0.856 | |
| | 300 | 26.3 | 21.65 | 0.823 | |
| 11 | 77 | 33 | 33 | 0.999 | 1.3968 |
| | 100 | 26.6 | 26.2 | 0.986 | |
| | 210 | 12.5 | 11.55 | 0.925 | |
| | 300 | 8.35 | 7.31 | 0.875 | |
| 12 | 77 | 50 | 48 | 0.954 | 1.4021 |
| | 100 | 41.5 | 39.1 | 0.943 | |
| | 210 | 17.0 | 15.2 | 0.894 | |
| | 300 | 8.6 | 7.31 | 0.850 | |
| 13 | 77 | 441 | 483 | 1.096 | 1.535 |
| | 100 | 238 | 259 | 1.087 | |
| | 210 | 33.0 | 34.5 | 1.045 | |
| | 300 | 13.75 | 13.87 | 1.009 | |
| 14 | 77 | 85 | 89 | 1.050 | 1.4946 |
| | 100 | 58.8 | 61.2 | 1.040 | |
| | 210 | 17.5 | 17.4 | 0.994 | |
| | 300 | 8.62 | 8.25 | 0.957 | |
| I | 77 | 106 | 103 | 0.906 | 1.40 |
| | 100 | 82.7 | 79.2 | | |
| | 210 | 33.8 | 30.6 | 1.23 | |
| J | 77 | 135 | 166 | 1.17 | 1.38 |
| | 100 | 77.2 | 95.0 | | |
| | 210 | 14.4 | 16.9 | | |

Table II

(continued)

| Fluid | Temp (F) | Viscosity cs | Viscosity cp | Density gm/ml | Refractive Index (White Light) |
|---|---|---|---|---|---|
| 9 | 77 | 1864 | 1683 | 0.903 | 1.4488 |
| | 100 | 1212 | 1085 | 0.895 | |
| | 210 | 274 | 235 | 0.856 | |
| | 300 | 131 | 108 | 0.825 | |
| 10 | 77 | 373 | 337 | 0.904 | 1.4475 |
| | 100 | 239 | 214 | 0.896 | |
| | 210 | 55 | 47 | 0.856 | |
| | 300 | 26.3 | 21.65 | 0.823 | |
| 11 | 77 | 33 | 33 | 0.999 | 1.3968 |
| | 100 | 26.6 | 26.2 | 0.986 | |
| | 210 | 12.5 | 11.55 | 0.925 | |
| | 300 | 8.35 | 7.31 | 0.875 | |
| 12 | 77 | 50 | 48 | 0.954 | 1.4021 |
| | 100 | 41.5 | 39.1 | 0.943 | |
| | 210 | 17.0 | 15.2 | 0.894 | |
| | 300 | 8.6 | 7.31 | 0.850 | |
| 13 | 77 | 441 | 483 | 1.096 | 1.535 |
| | 100 | 238 | 259 | 1.087 | |
| | 210 | 33.0 | 34.5 | 1.045 | |
| | 300 | 13.75 | 13.87 | 1.009 | |
| 14 | 77 | 85 | 89 | 1.050 | 1.4946 |
| | 100 | 58.8 | 61.2 | 1.040 | |
| | 210 | 17.5 | 17.4 | 0.994 | |
| | 300 | 8.62 | 8.25 | 0.957 | |
| I | 77 | 106 | 103 | 0.906 | 1.40 |
| | 100 | 82.7 | 79.2 | | |
| | 210 | 33.8 | 30.6 | 1.23 | |
| J | 77 | 135 | 166 | 1.17 | 1.38 |
| | 100 | 77.2 | 95.0 | | |
| | 210 | 14.4 | 16.9 | | |

Table IIIa

Pressure Viscosity Characteristics - $\alpha_{OT}$

$\alpha_{OT} \times 10^4 \ (psi)^{-1}$

| Fluids | 75°F* | 100°F | 210°F | 300°F |
|---|---|---|---|---|
| 1 | 1.450 | 1.352 | 1.037 | 1.139 |
| 2 | 0.800 | 0.770 | 0.539 | 0.486 |
| 3 | 0.990 | 1.079 | 1.205 | 1.010 |
| 4 | 0.900 | 1.011 | 1.323 | 0.998 |
| 6 | 1.600 | 1.102 | 0.664 | 1.097 |
| 7 | 1.080 | 1.050 | 1.000 | 1.050 |
| 8 | 0.900 | 1.127 | 1.622 | 1.546 |
| 9 | 0.890 | 0.851 | 0.885 | 1.075 |
| 10 | 0.970 | 0.990 | 1.007 | 1.164 |
| 11 | 0.450 | 0.722 | 1.774 | 2.055 |
| 12 | 1.070 | 1.355 | 2.048 | 2.419 |
| 13 | 2.100 | 1.715 | 1.086 | 1.497 |
| 14 | 2.550 | 2.087 | 0.987 | 1.253 |
| I | 1.130 | 1.180 | 1.440 | --- |
| J | 1.370 | 1.420 | 1.770 | --- |
| DC-200-500 cs. | 1.50 | | 1.50 | |

*Extrapolated Data except for DC-200-500 cs.

Table IIIb

Pressure Viscosity Characteristics - α*

$\alpha^{*} \times 10^{4}\ (\text{psi})^{-1}$

| Fluids | 75°F* | 100°F | 210°F | 300°F |
|---|---|---|---|---|
| 1 | 0.990 | 0.944 | 0.735 | 0.661 |
| 2 | 0.830 | 0.805 | 0.695 | 0.597 |
| 3 | 0.950 | 0.911 | 0.772 | 0.675 |
| 4 | 0.900 | 0.903 | 0.792 | 0.655 |
| 6 | 1.120 | 0.914 | 0.667 | 0.692 |
| 7 | 1.070 | 1.050 | 1.000 | 1.050 |
| 8 | 0.942 | 0.935 | 0.827 | 0.747 |
| 9 | 0.890 | 0.862 | 0.720 | 0.648 |
| 10 | 0.910 | 0.892 | 0.742 | 0.669 |
| 11 | 0.615 | 0.628 | 0.675 | 0.700 |
| 12 | 0.980 | 0.963 | 0.956 | 0.955 |
| 13 | 1.910 | 1.790 | 1.104 | 0.987 |
| 14 | 1.750 | 1.520 | 0.891 | 0.869 |
| I | 0.850 | 0.860 | 0.980 | --- |
| J | 1.410 | 1.350 | 1.150 | --- |
| DC-200-500 cs. | 1.342 | | | |

*Extrapolated Data except for DC-200-500cs.

Table IIIc

Pressure Viscosity Characteristics - Z

(Roeland Slope Index)

| Fluids | 75°F* | 100°F | 210°F | 300°F |
|---|---|---|---|---|
| 1 | 0.515 | 0.517 | 0.522 | 0.514 |
| 2 | 0.240 | 0.245 | 0.256 | 0.238 |
| 3 | 0.451 | 0.448 | 0.430 | 0.429 |
| 4 | 0.450 | 0.444 | 0.341 | 0.323 |
| 6 | 0.324 | 0.321 | 0.296 | 0.287 |
| 7 | 0.318 | 0.315 | 0.309 | 0.378 |
| 8 | 0.321 | 0.323 | 0.307 | 0.291 |
| 9 | 0.335 | 0.325 | 0.304 | 0.292 |
| 10 | 0.391 | 0.384 | 0.372 | 0.357 |
| 11 | 0.392 | 0.389 | 0.364 | 0.370 |
| 12 | 0.522 | 0.506 | 0.436 | 0.427 |
| 13 | 0.815 | 0.765 | 0.522 | 0.499 |
| 14 | 0.705 | 0.685 | 0.528 | 0.507 |
| I | 0.500 | 0.495 | 0.436 | --- |
| J | 0.621 | 0.614 | 0.584 | --- |
| DC-200-500 cs. | 0.353 | | 0.315 | |

*Extrapolated Data except for DC-200-500 cs.

## Table IIId

## Pressure Viscosity Characteristics at 25C from Bridgman's Data (1)

| Siloxane Fluid* | $\alpha_{OT}$ $psi^{-1} \times 10^4$ | $\alpha^*$ $psi^{-1} \times 10^4$ | Z |
|---|---|---|---|
| Trimer | 0.89 | 0.679 | 0.688 |
| Tetramer | 1.08 | 0.775 | 0.655 |
| Hexamer | 1.12 | 0.810 | 0.592 |
| Octamer | 0.98 | 0.788 | 0.607 |
| 500-1.00 cs | 1.10 | 0.695 | 0.658 |
| 500-2.00 cs | 1.01 | 0.618 | 0.638 |
| 500-12.8 cs | 1.06 | 0.899 | 0.582 |
| 200-10.0 cs (100 cs) | 0.92 | 0.832 | 0.416 |

*Fluid designations employed here are those used in Bridgman's paper. However, the "500" fluids and the "200" fluids are referred to in that paper as mixtures of dimethyl siloxane polymers and are therefore all commonly known as 200-fluids today. The fluid 200-10.0 cs in the Bridgman reference was mislabeled and was actually a 100 cs dimethyl fluid (private communication from Dr. A. J. Barry of Dow Corning, November 1970).

Table IV

Roelands Temperature Viscosity

Slope Index S at Atmospheric Pressure

| Fluid | S |
|---|---|
| 1 | 0.88 |
| 2 | 0.50 |
| 3 | 0.74 |
| 4 | 0.58 |
| 6 | 0.55 |
| 7 | 0.58 |
| 8 | 0.51 |
| 9 | 0.54 |
| 10 | 0.66 |
| 11 | 0.48 |
| 12 | 0.55 |
| 13 | 0.87 |
| 14 | 0.70 |
| I | 0.48 |
| J | 0.96 |
| DC-200-500 cs | 0.48 |

Table V

Elastohydrodynamic Film Thickness

and Traction Data*

| Fluid | Speed (ips | $h_c$ (μ-in) | $h_m$ (μ-in) | TC |
|---|---|---|---|---|
| 1 | 13.7 | 1 | 1 | .057 |
| | 27.4 | 1 | 1 | .048 |
| 2 | 13.7 | 14 | 8 | .043 |
| | 27.4 | 22 | 14 | .036 |
| 3 | 13.7 | 4 | 2 | .055 |
| | 27.4 | 7 | 3 | .048 |
| 4 | 13.7 | 10 | 5 | .053 |
| | 27.4 | 14 | 8 | .044 |
| 6 | 13.7 | 12 | 7 | .049 |
| | 27.4 | 17 | 10 | .038 |
| 7 | 13.7 | 14 | 8 | .046 |
| | 27.4 | 19 | 13 | .036 |
| 8 | 13.7 | 9 | 5 | .051 |
| | 27.4 | 14 | 8 | .042 |
| 9 | 13.7 | 11 | 6 | .050 |
| | 27.4 | 15 | 9 | .046 |
| 10 | 13.7 | 8 | 3 | .052 |
| | 27.4 | 11 | 5 | .043 |
| 12 | 13.7 | 2 | 1 | .069 |
| | 27.4 | 3 | 2 | .061 |
| 13 | 13.7 | 22 | 13 | .089 |
| | 27.4 | 31 | 22 | .075 |
| 14 | 13.7 | 12 | 9 | .091 |
| | 27.4 | 16 | 11 | .082 |
| I | 13.7 | 1 | 1 | .069 |
| | 27.4 | 2 | 1 | .053 |
| J | 13.7 | 7 | 2 | .069 |
| | 27.4 | 9 | 5 | .054 |

*All data taken at 15 lb load (150,000 psi peak Hertz pressure)

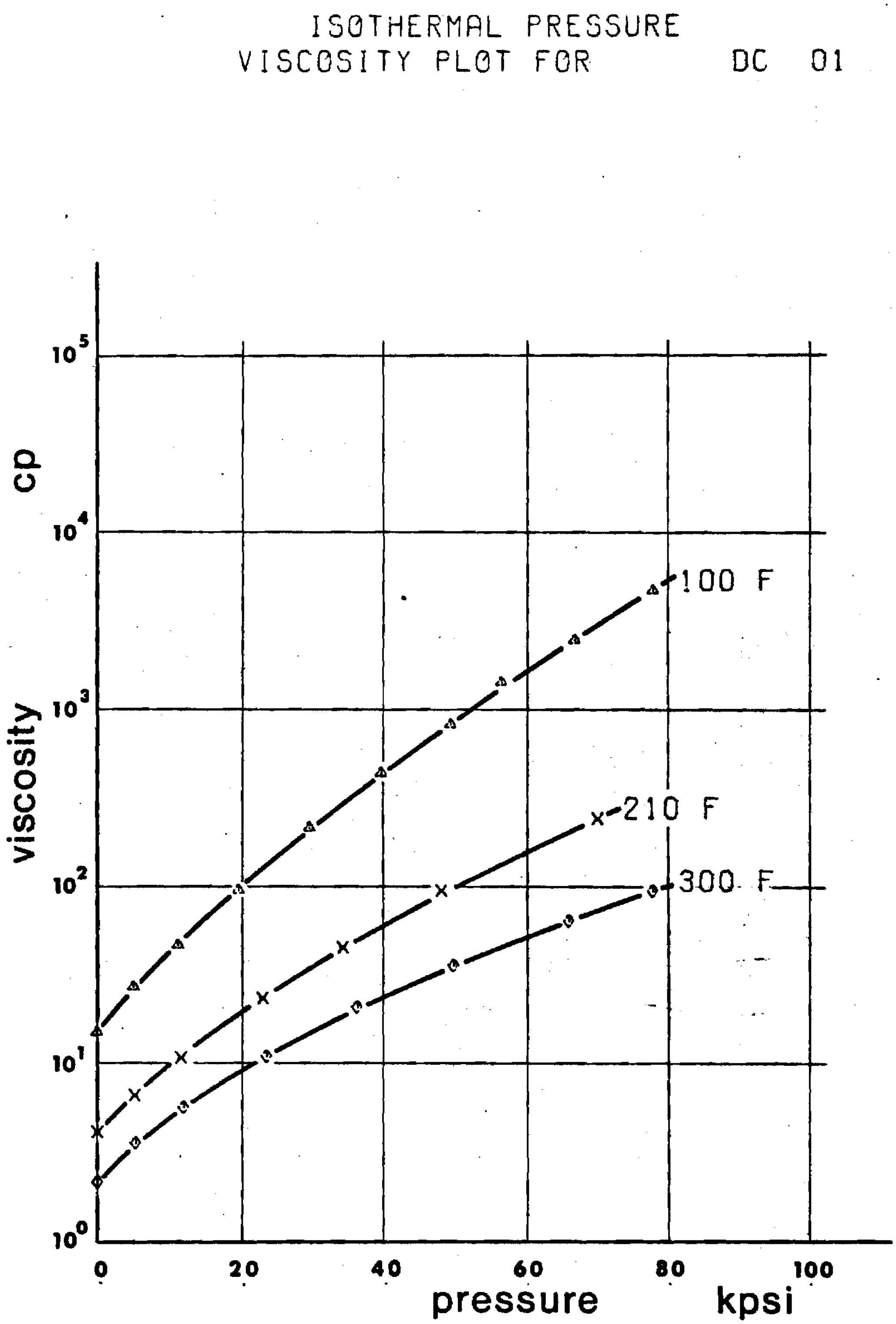
## Energy Input Rates in EHD Contacts

| DC Fluid | $\mu_0$(77F) cp | MW awu | DP | Side Radical | $E \times 10^{-3}$ $\frac{kcal}{cm^3 sec}$ U=13.7 ips | $E \times 10^{-3}$ $\frac{kcal}{cm^3 sec}$ U=27.4 ips | $\Sigma \times 10^{-3}$ $\frac{kcal}{gmole}$ U=13.7 ips | $\Sigma \times 10^{-3}$ $\frac{kcal}{gmole}$ U=27.4 ips |
|---|---|---|---|---|---|---|---|---|
| 11 | 29.5 | 2400 | 35 | H | --- | --- | --- | --- |
| 12 | 50 | 3300 | 43 | $CH_3$ | 86.5 | 102.0 | 421.0 | 248.0 |
| 8 | 1740 | 5200 | 35 | $C_6H_{13}$ | 14.2 | 15.0 | 108.9 | 57.7 |
| 9 | 1660 | 6200 | 35 | $C_8H_{17}$ | 11.4 | 15.3 | 103.5 | 69.8 |
| 6 | 2100 | 7200 | 35 | $C_{10}H_{21}$ | 10.2 | 11.2 | 108.7 | 59.5 |
| 2 | 7800 | 8200 | 35 | $C_{12}H_{25}$ | 7.7 | 8.2 | 93.0 | 49.6 |
| 7 | 3020 | 9200 | 35 | $C_{14}H_{29}$ | 8.2 | 9.5 | 111.7 | 64.3 |
| 5 | solid | 10200 | 35 | $C_{16}H_{33}$ | --- | --- | --- | --- |
| 1 | 22 | 940 | 4→5 | $C_8H_{17}$ | 143.0 | 240.7 | 197.6 | 166.4 |
| 3 | 95 | 2220 | 12 | $C_8H_{17}$ | 34.0 | 34.4 | 113.0 | 56.4 |
| 10 | 344 | 3600 | 20 | $C_8H_{17}$ | 16.3 | 19.6 | 86.6 | 52.0 |
| 4 | 708 | 4300 | 25 | $C_8H_{17}$ | 13.3 | 15.8 | 83.6 | 49.5 |
| 9 | 1660 | 5200 | 35 | $C_8H_{17}$ | 11.4 | 15.3 | 103.5 | 69.8 |

Table VI

(continued)

| DC Fluid | $\mu_0$(77F) cp | MW awu | DP | Side Radical | $E \times 10^{-3}$ $\frac{kcal}{cm^3 sec}$ U=13.7 ips | $E \times 10^{-3}$ $\frac{kcal}{cm^3 sec}$ U=27.4 ips | $\Sigma \times 10^{-3}$ $\frac{kcal}{gmole}$ U=13.7 ips | $\Sigma \times 10^{-3}$ $\frac{kcal}{gmole}$ U=27.4 ips |
|---|---|---|---|---|---|---|---|---|
| 12 | 50 | 3300 | 43 | $CH_3$ | 86.5 | 102.0 | 421.0 | 248.0 |
| I | 97 | 7000 | 70 | $CH_3$ | 192.0 | 156.0 | 1986.5 | 808.0 |
| J | 166 | 4000 | 30 | $[CH_2]_2CF_3$ | 24.7 | 29.4 | 146.0 | 87.0 |
| 13 | 625 | 2600 | 12 | $CH_3-\phi$ | 10.1 | 12.1 | 39.0 | 23.3 |
| 14 | 113 | 2000 | 18 | $CH_3-\phi$ | 19.0 | 25.7 | 56.0 | 38.0 |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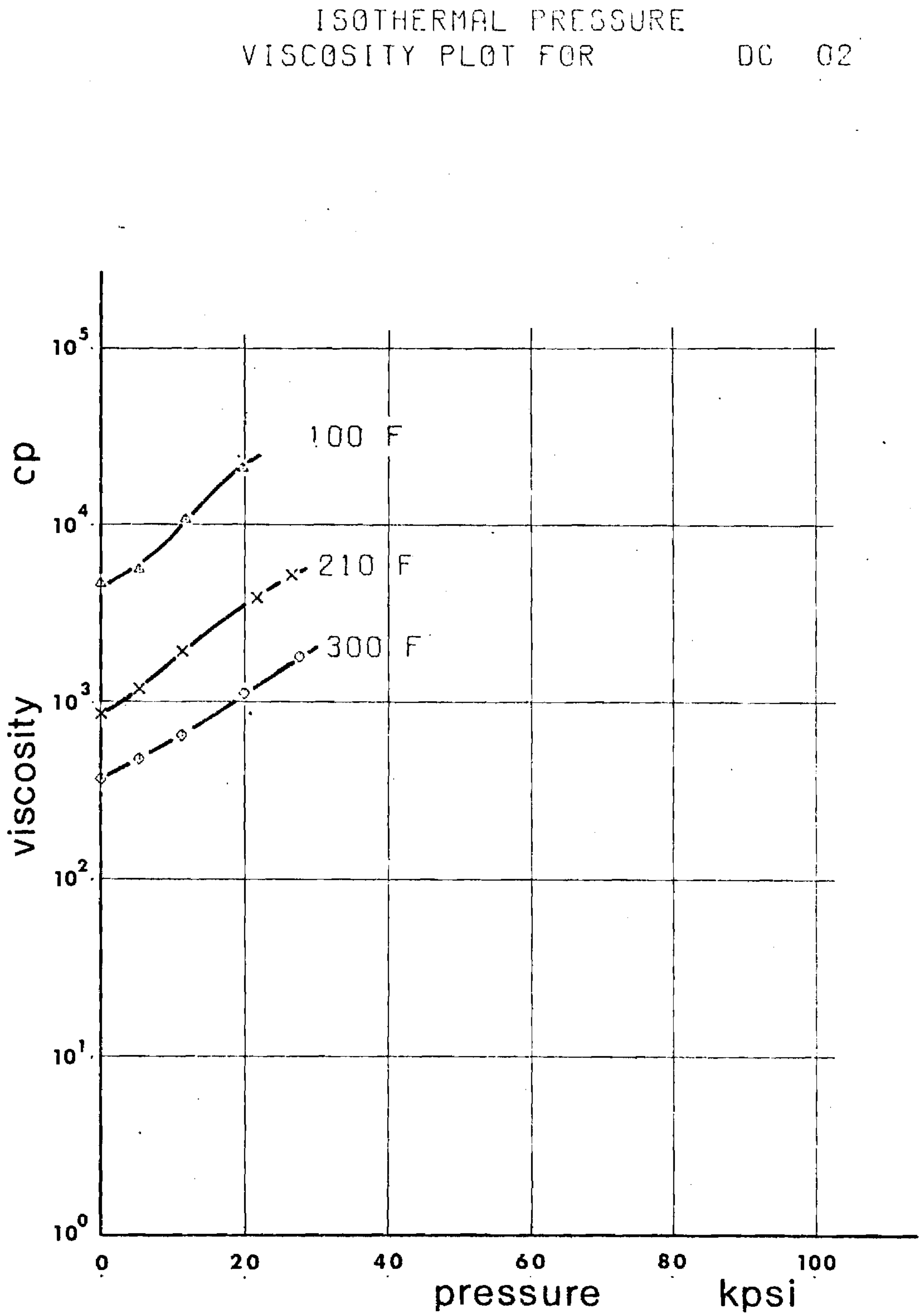
VISCOSITY PLOT FOR DC 01
viscosity cp
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
100 F
210 F
300 F
0
20
40
60
80
100
pressure kpsi

Figure 1-1



ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 02
viscosity cp
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
100 F
210 F
300 F
0
20
40
60
80
100
pressure kpsi


Figure 1-2

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 03

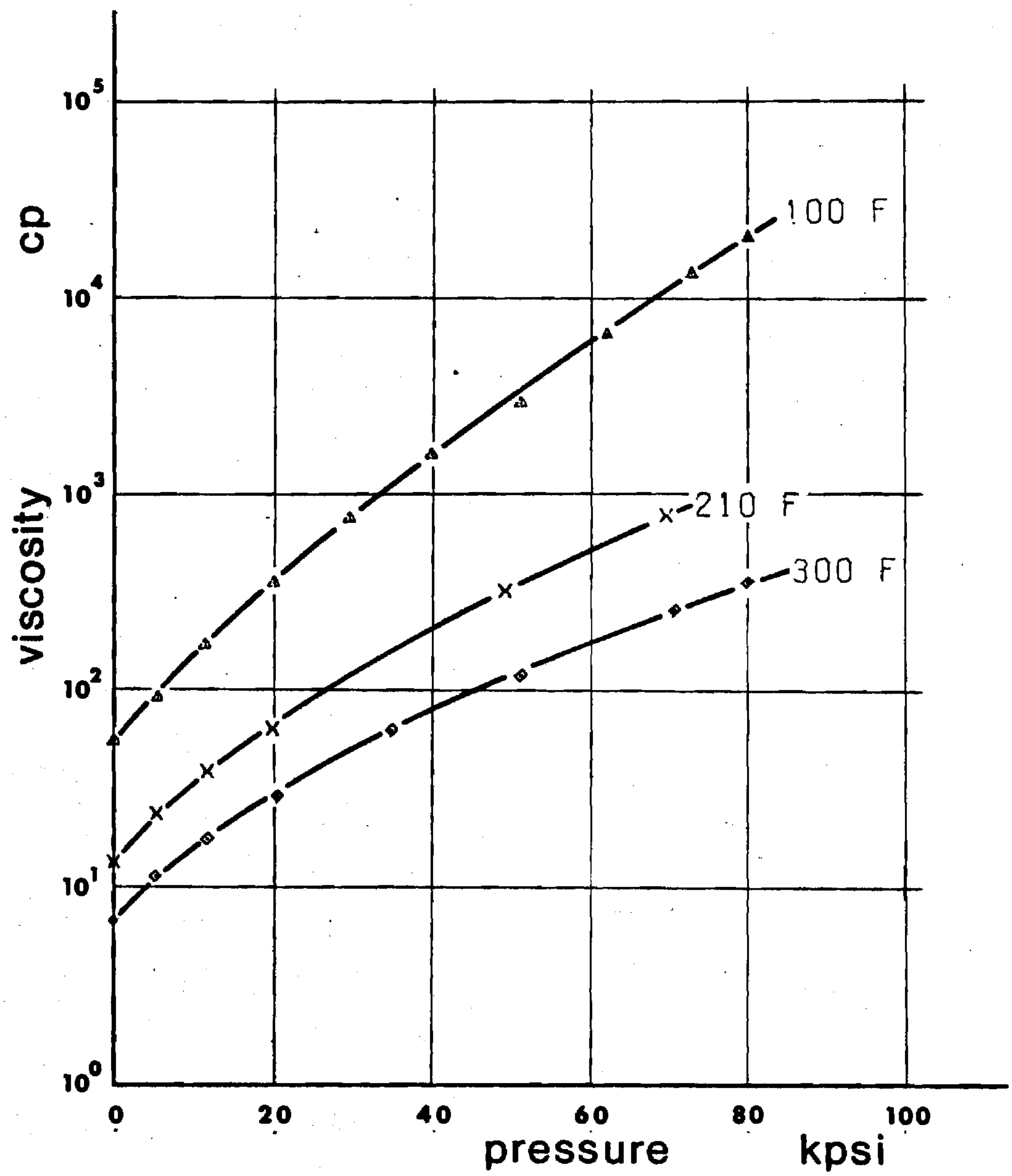



Figure 1-3

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC C4

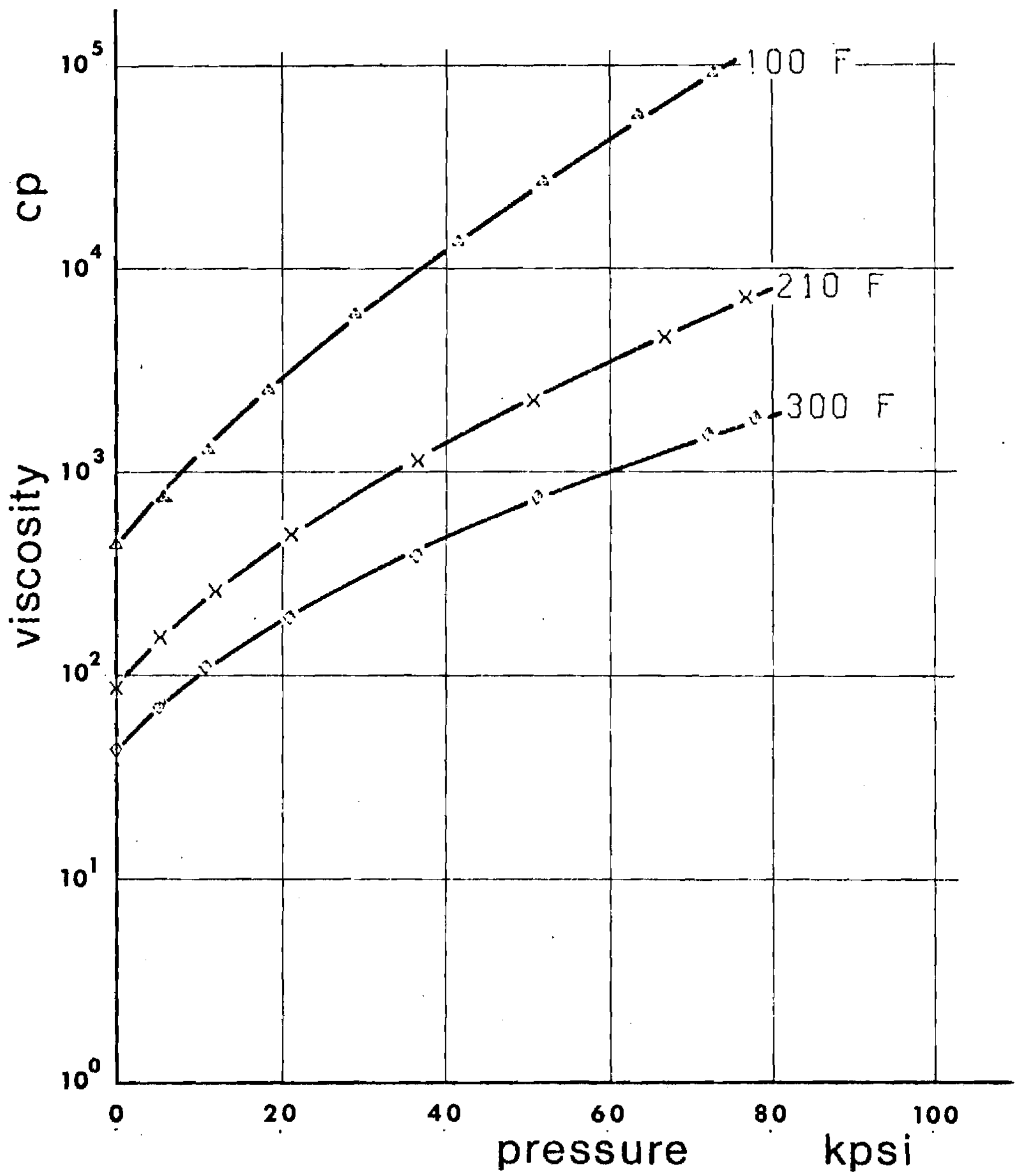



Figure 1-4

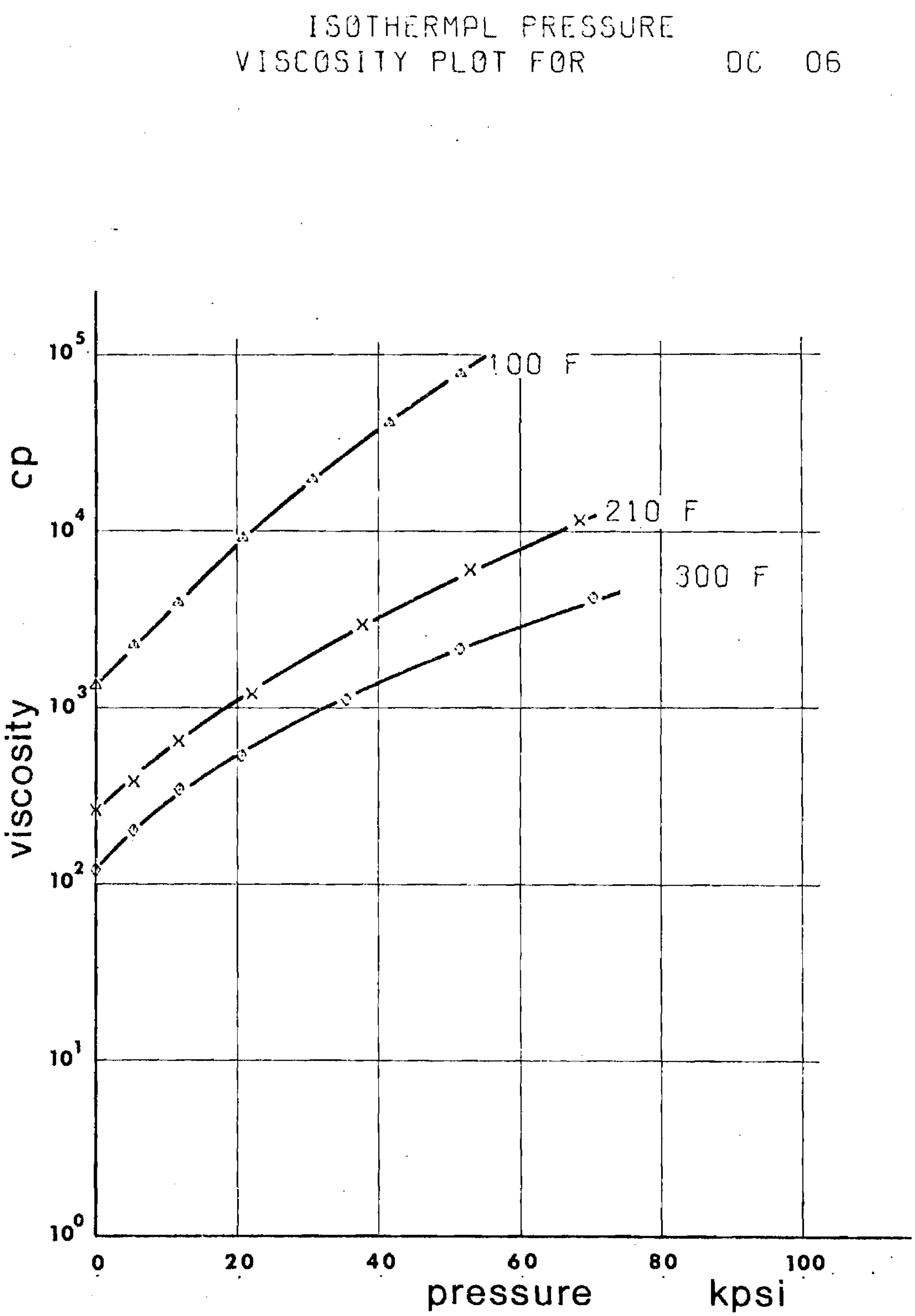
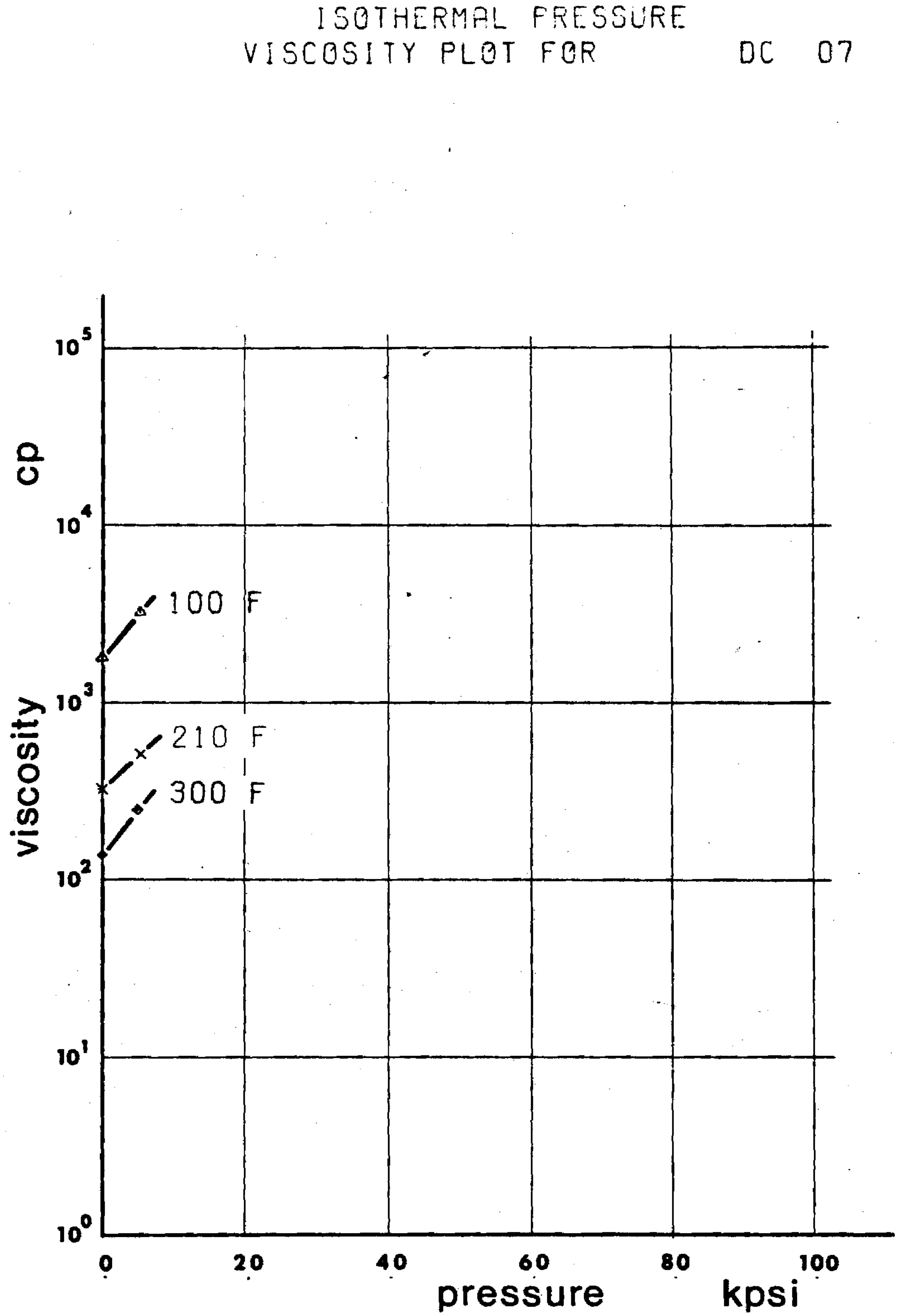

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 06
100 F
210 F
300 F
viscosity cp
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
0
20
40
60
80
100
pressure kpsi

Figure 1-6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VISCOSITY PLOT FOR DC 07
viscosity cp
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
100 F
210 F
300 F
0
20
40
60
80
100
pressure kpsi

Figure 1-7

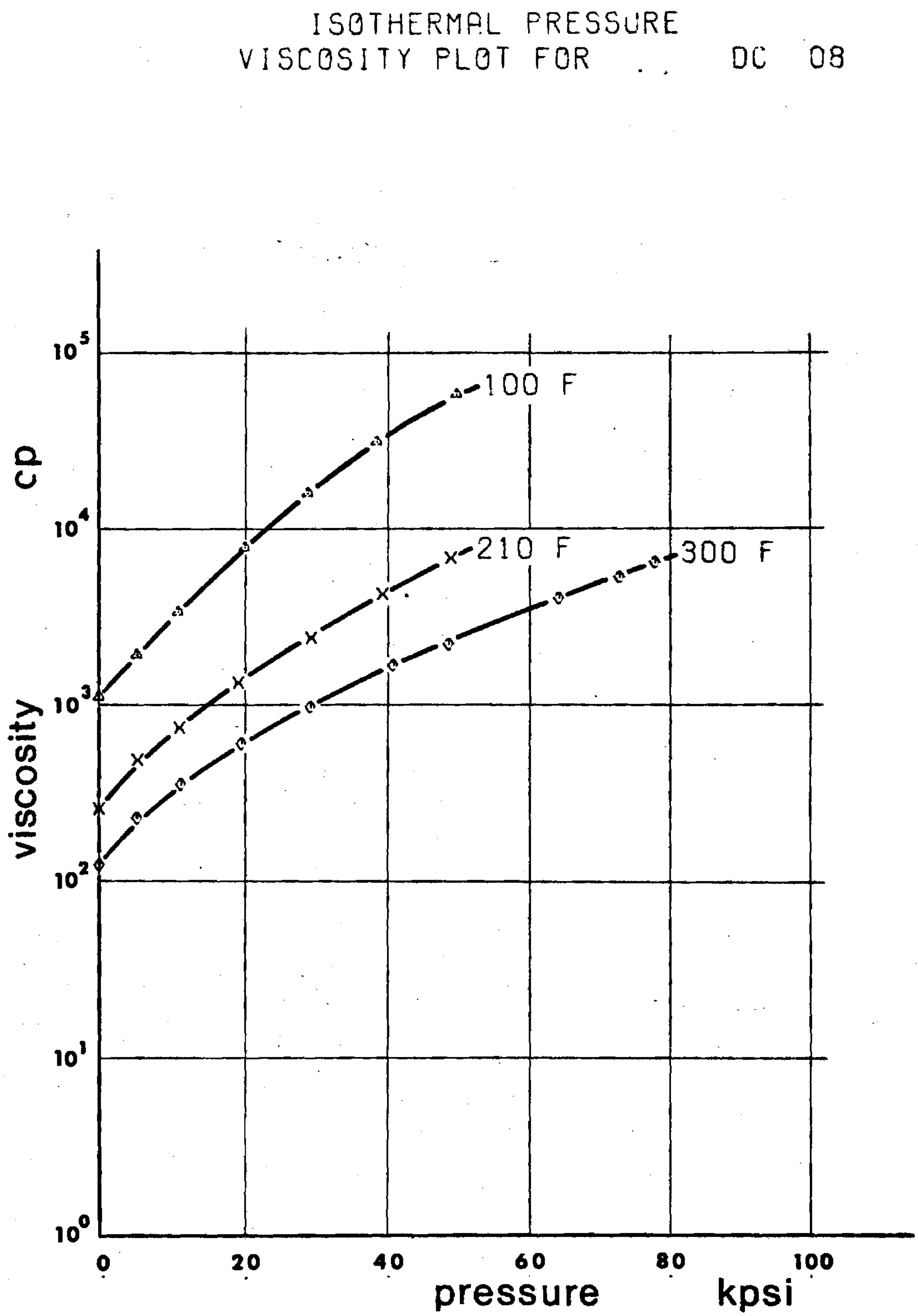

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 08
100 F
210 F
300 F
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
viscosity cp
0
20
40
60
80
100
pressure kpsi

Figure 1-8

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 09

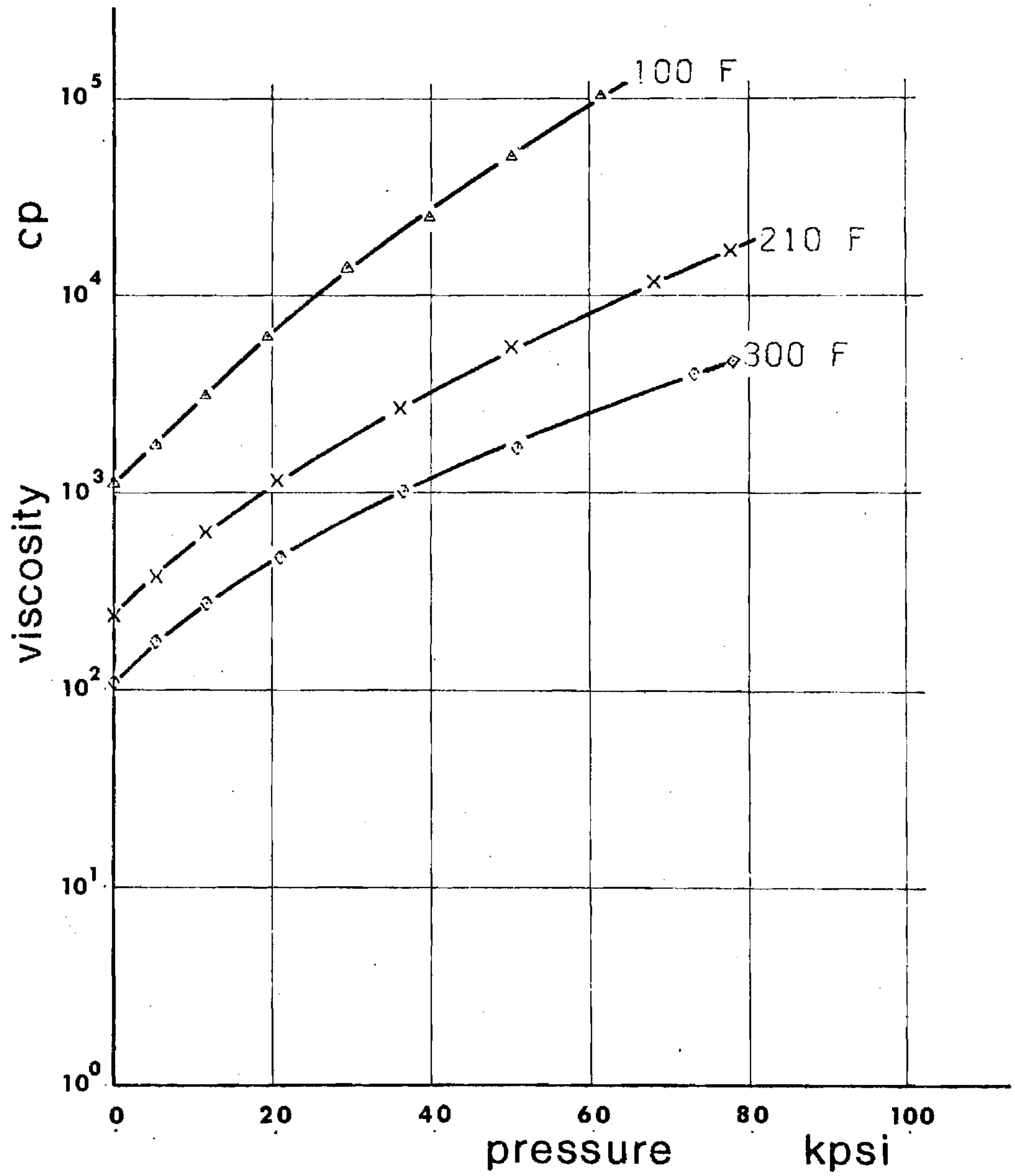



Figure 1-9

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 10

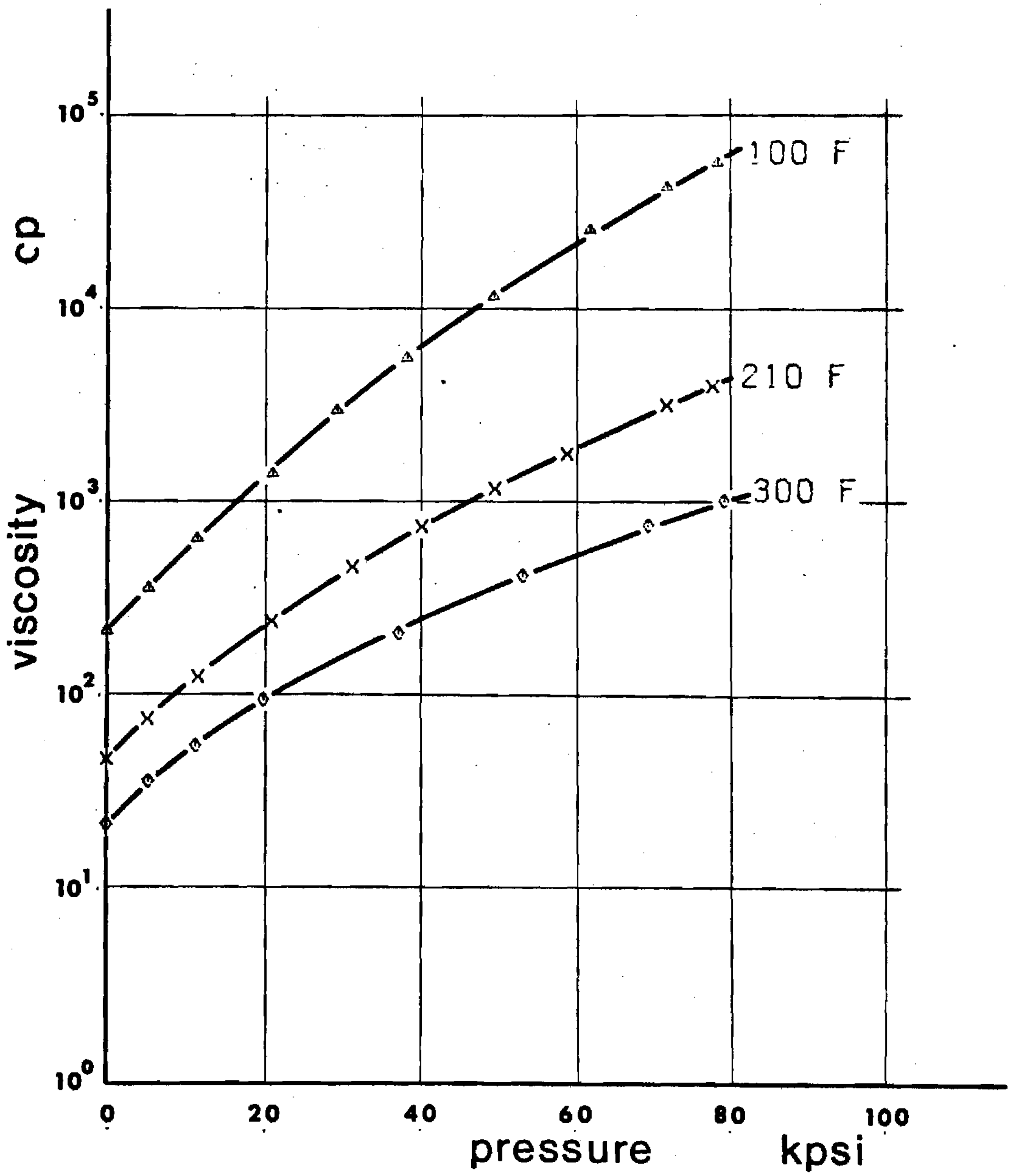



Figure 1-10

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 11

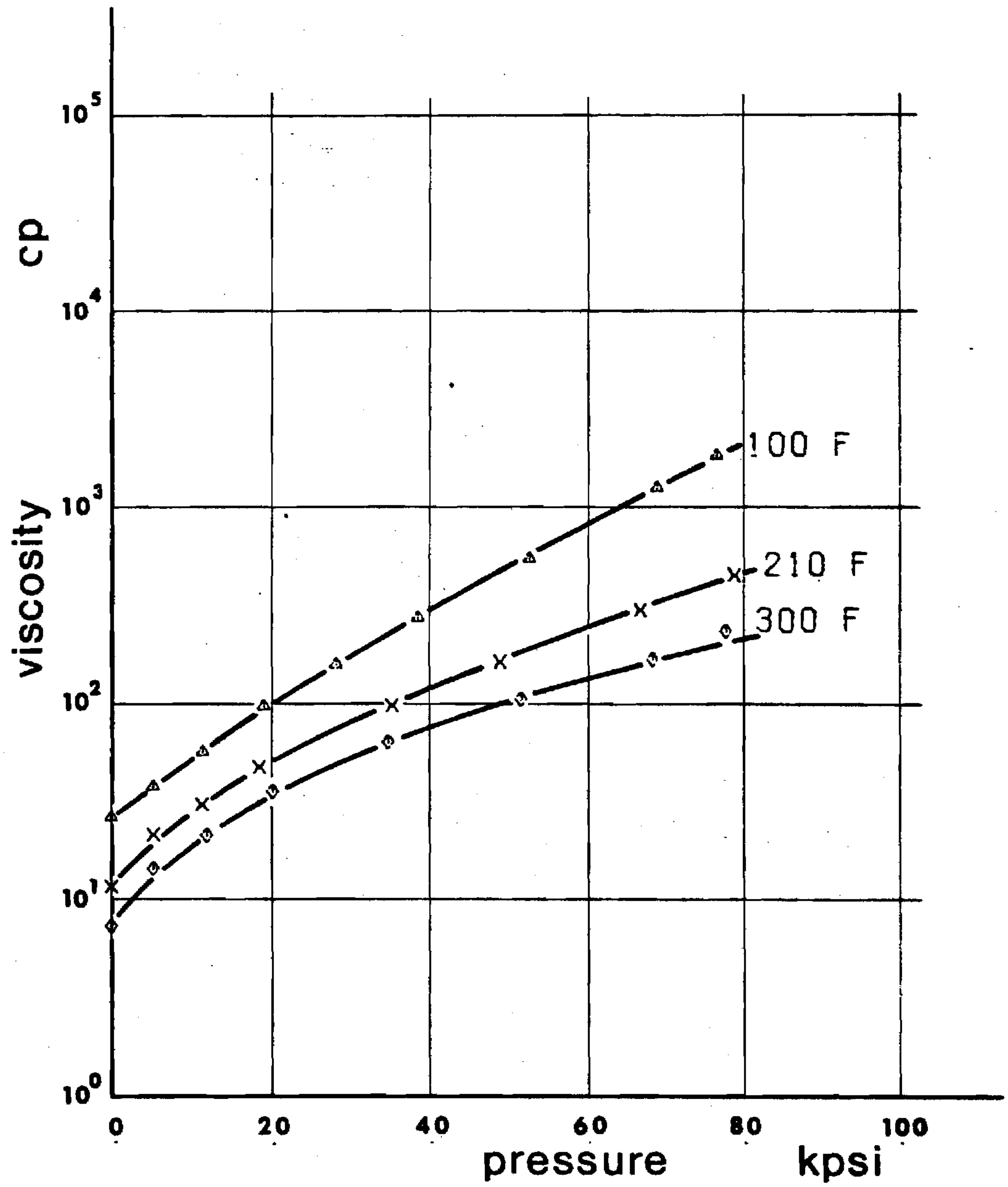
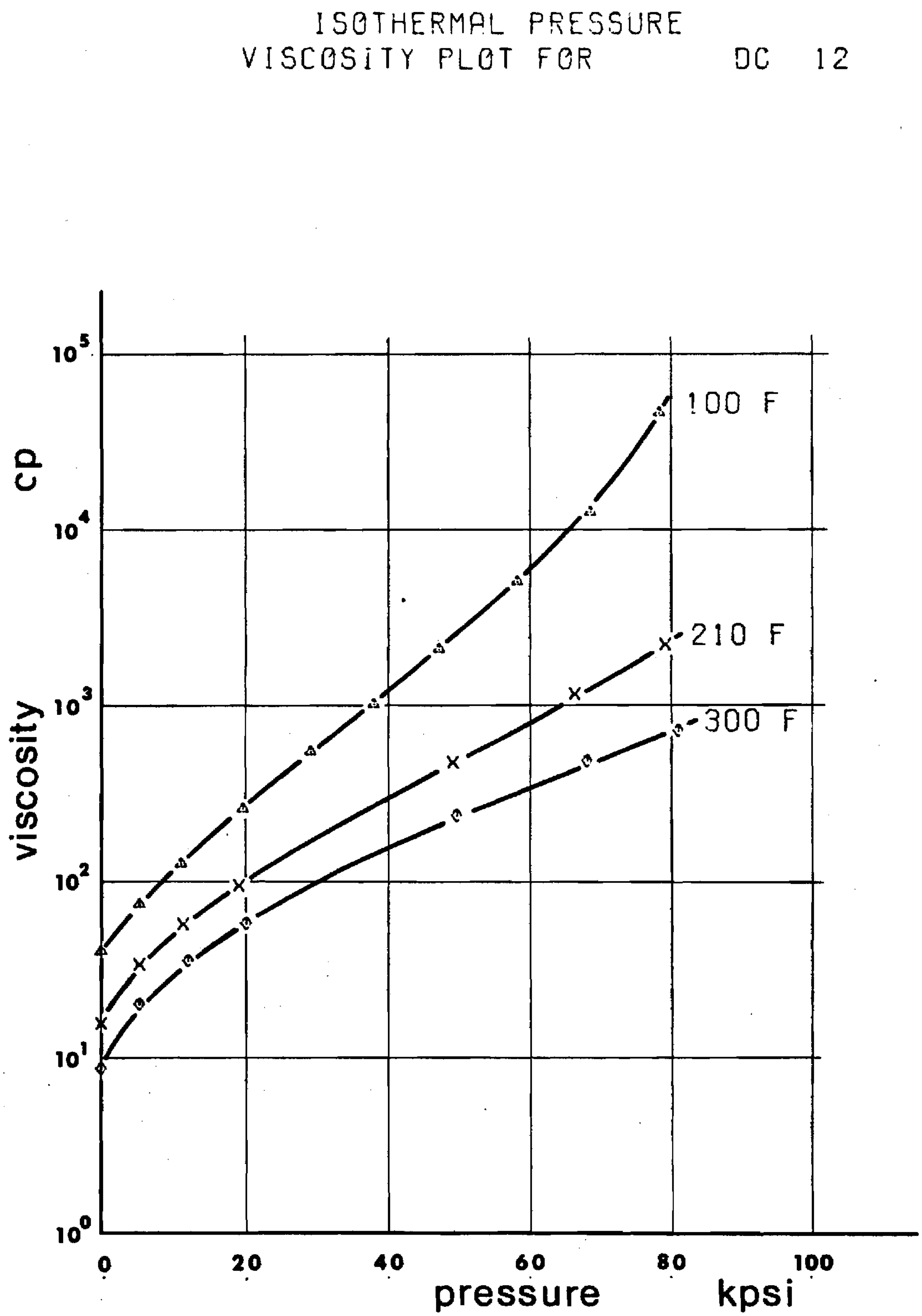



Figure 1-11



ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 12
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
viscosity cp
100 F
210 F
300 F
0
20
40
60
80
100
pressure kpsi


Figure 1-12

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 13

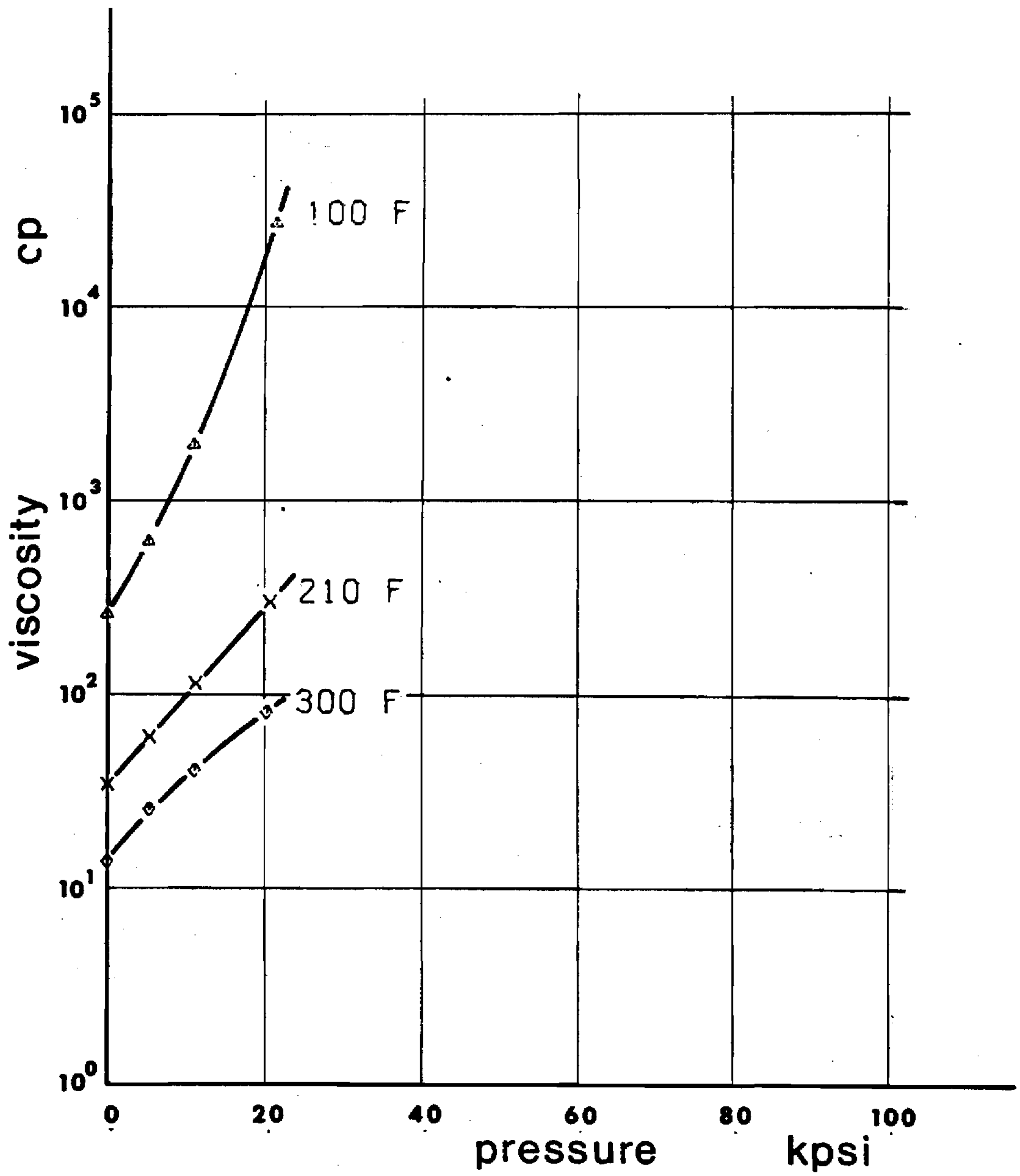



Figure 1-13

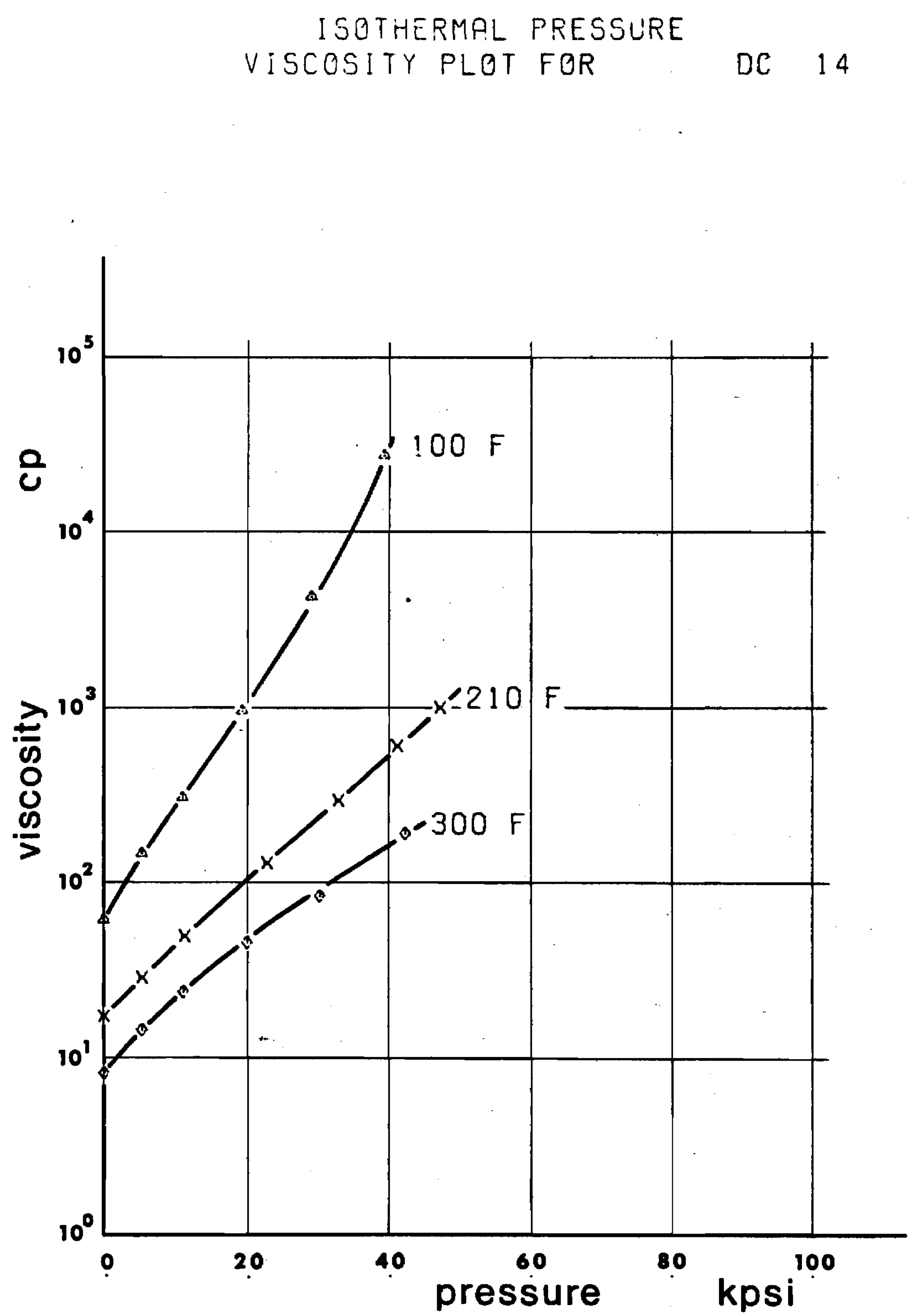

ISOTHERMAL PRESSURE
VISCOSITY PLOT FOR DC 14
viscosity cp
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
100 F
210 F
300 F
0
20
40
60
80
100
pressure kpsi

Figure 1-14

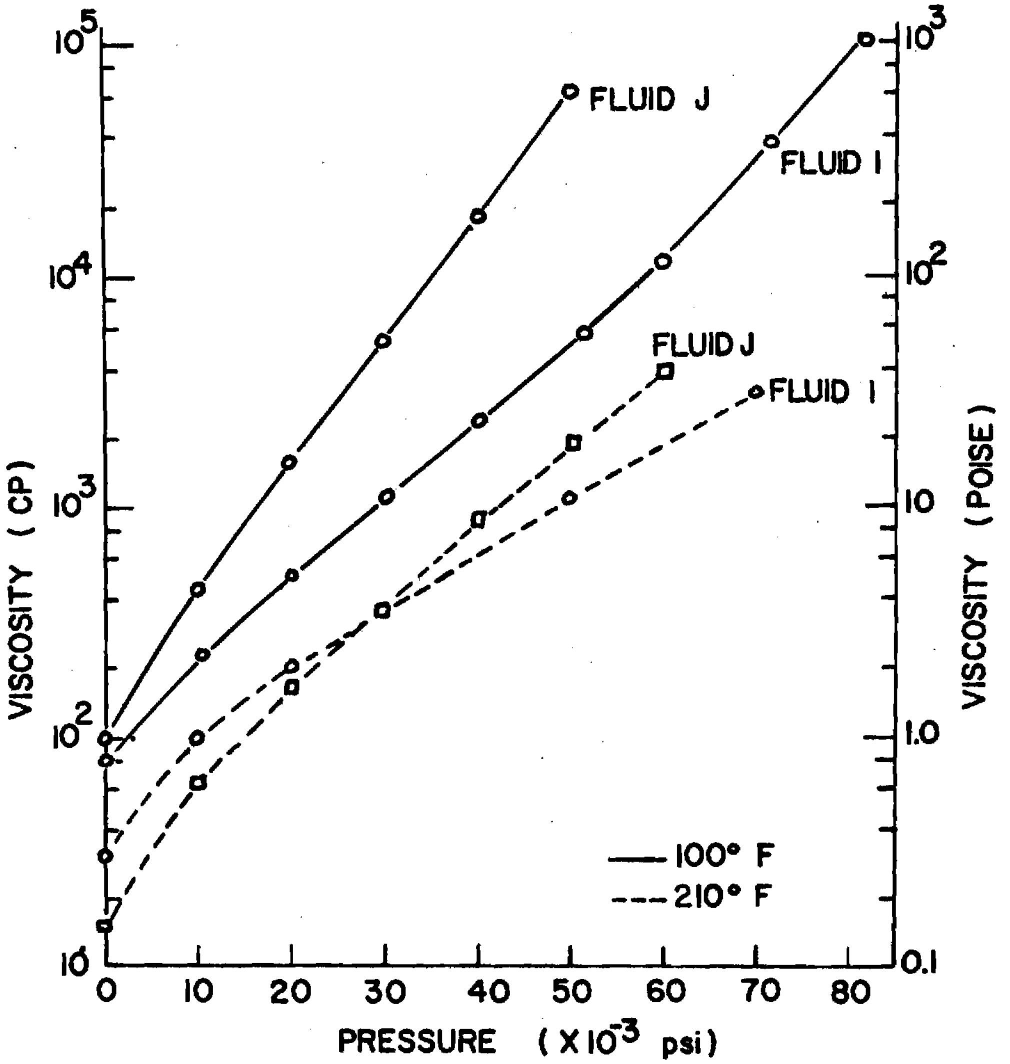
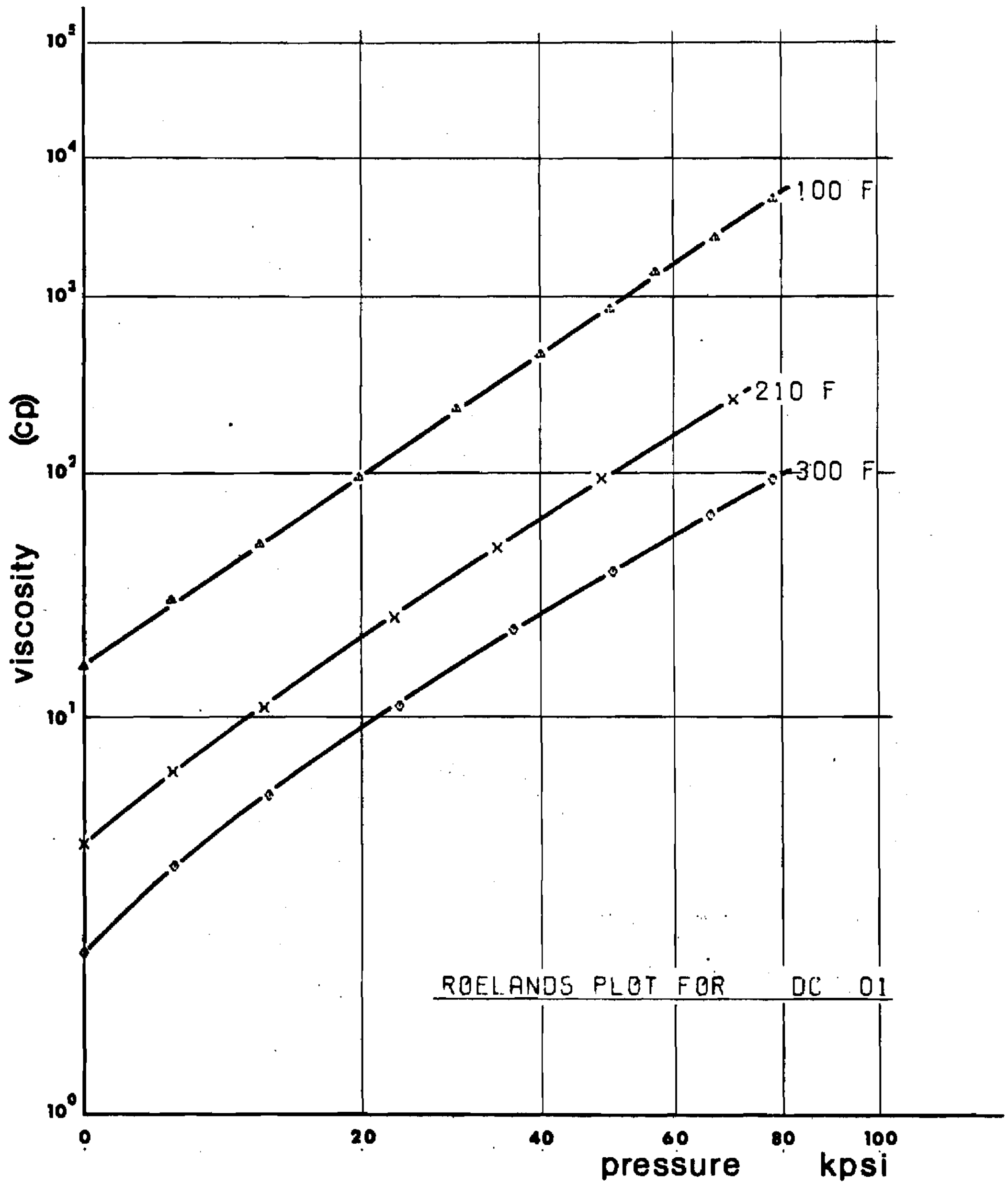
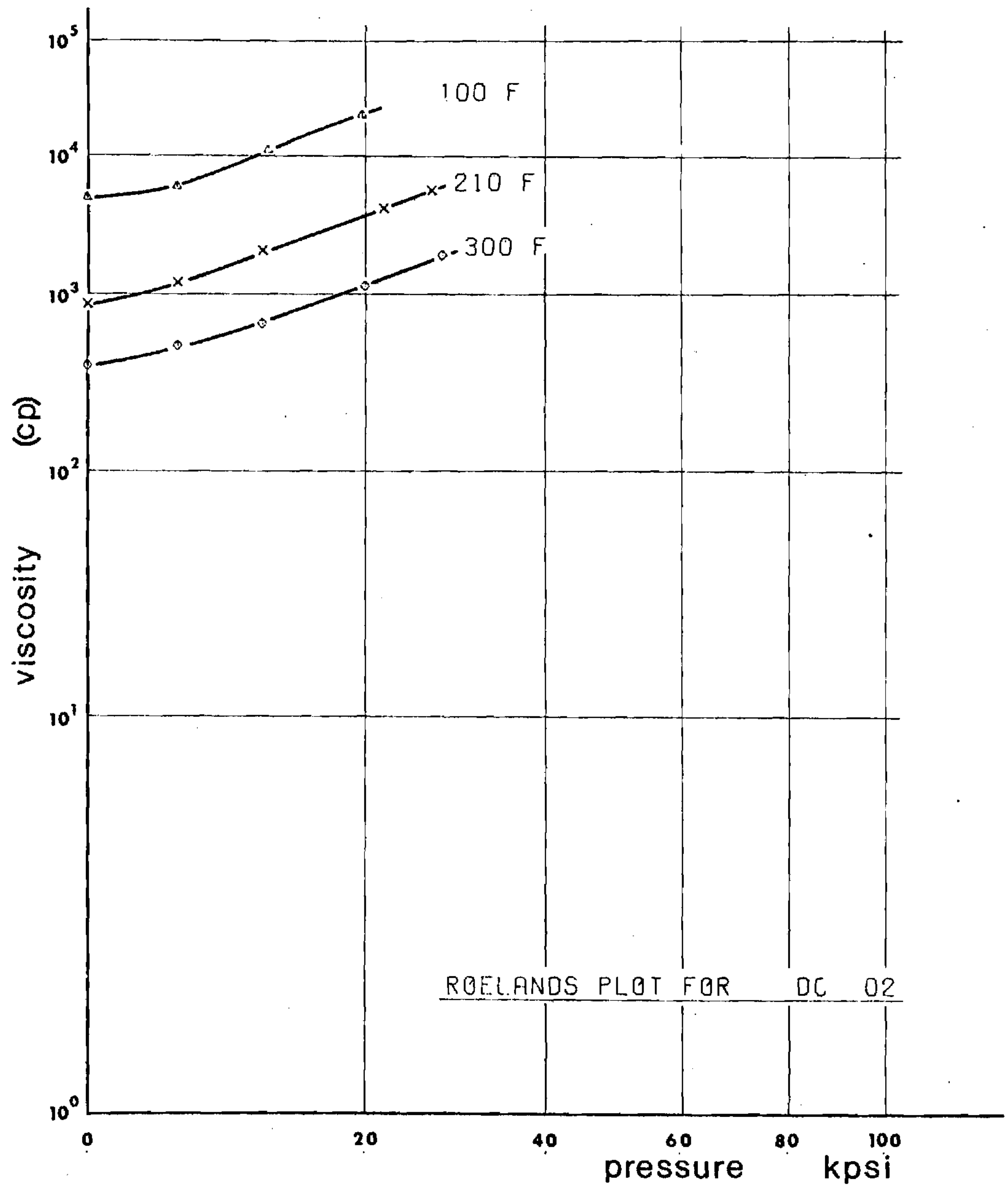



Figure 1-IJ. Viscosity-Pressure Relations for Fluids I and J.



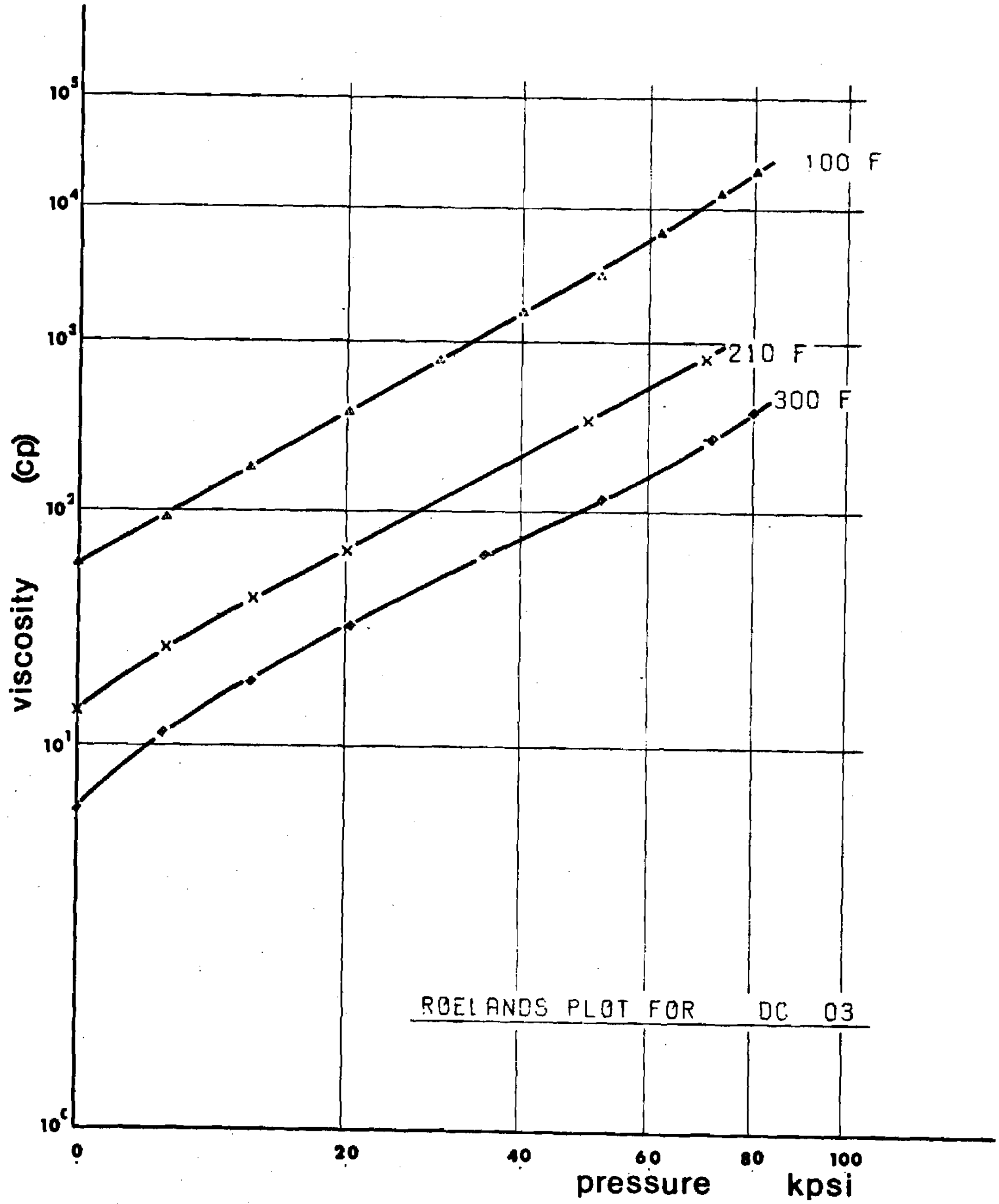
10^5
10^4
10^3
10^2
10^1
10^0
viscosity (cp)
100 F
210 F
300 F
ROELANDS PLOT FOR DC 01
0
20
40
60
80
100
pressure kpsi


Figure 2-1



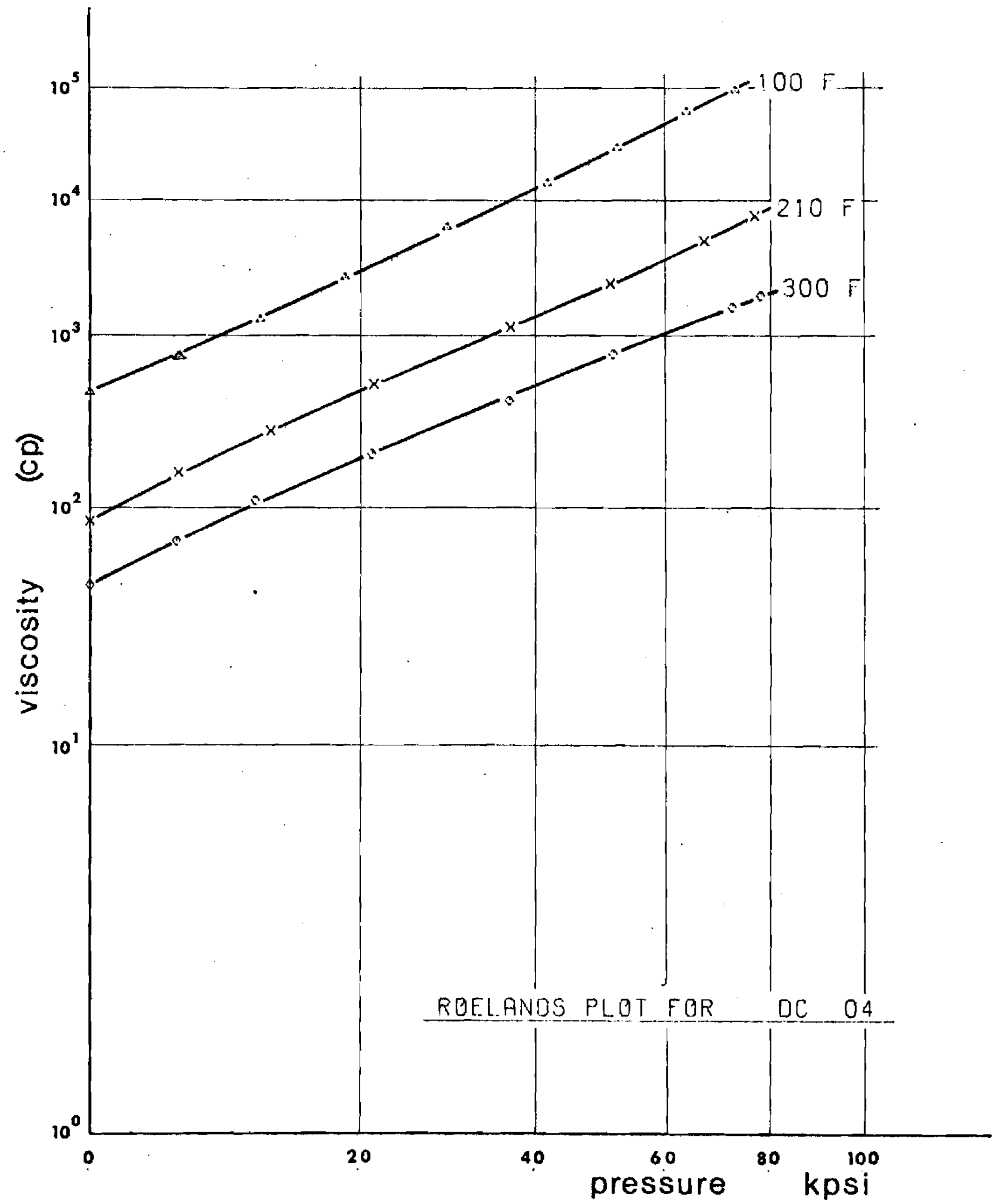
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
100 F
210 F
300 F
viscosity (cp)
ROELANDS PLOT FOR DC 02
0
20
40
60
80
100
pressure kpsi


Figure 2-2



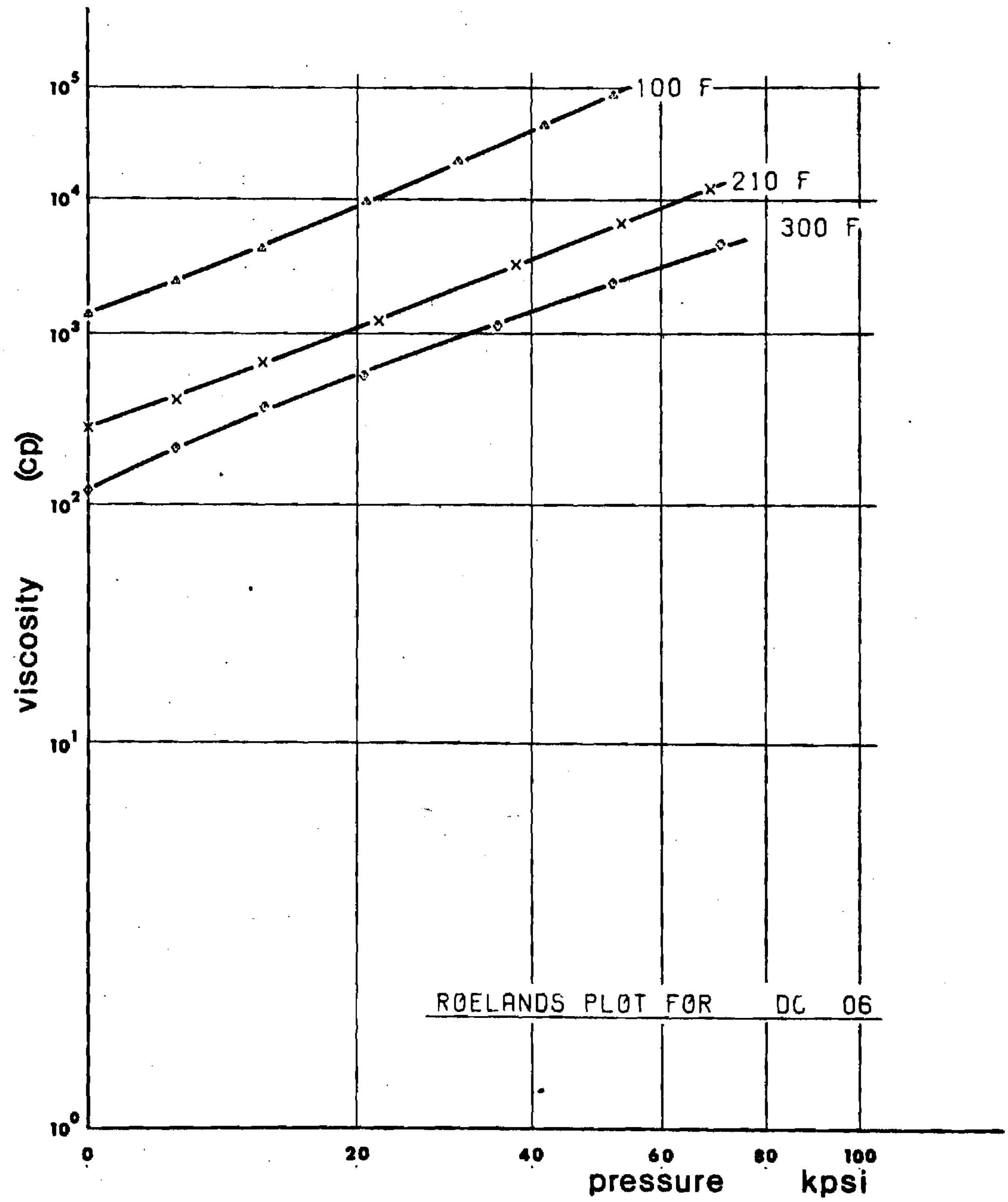
100 F
210 F
300 F
ROELANDS PLOT FOR DC 03
viscosity (cp)
pressure kpsi
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
0
20
40
60
80
100


Figure 2-3



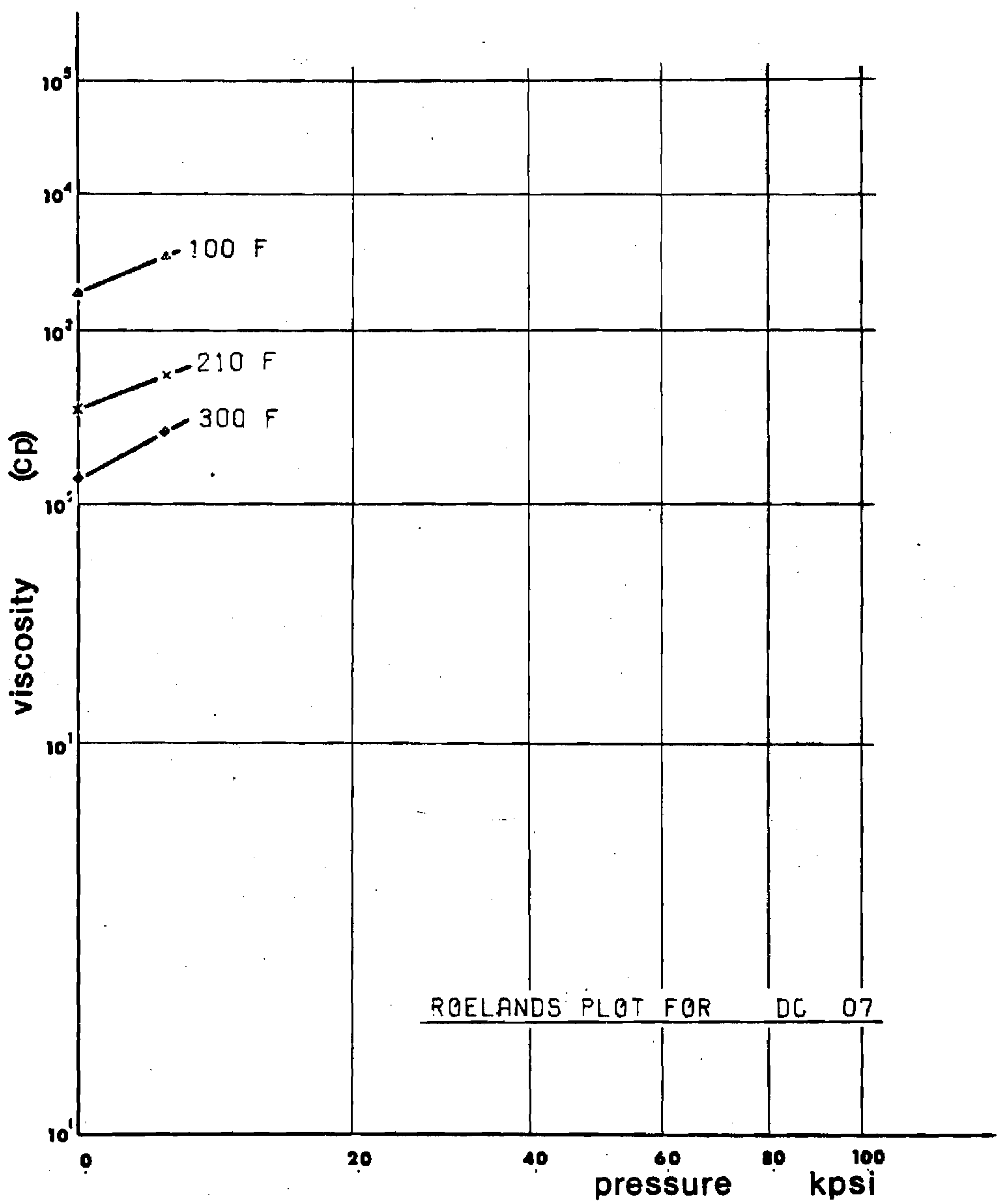
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
viscosity (cp)
100 F
210 F
300 F
ROELANDS PLOT FOR DC 04
0
20
40
60
80
100
pressure kpsi


Figure 2-4



100 F
210 F
300 F
ROELANDS PLOT FOR DC 06
viscosity (cp)
pressure kpsi
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
0
20
40
60
80
100


Figure 2-6



10⁵
10⁴
10³
10²
10¹
10⁰
viscosity (cp)
100 F
210 F
300 F
ROELANDS PLOT FOR DC 07
0
20
40
60
80
100
pressure kpsi


Figure 2-7

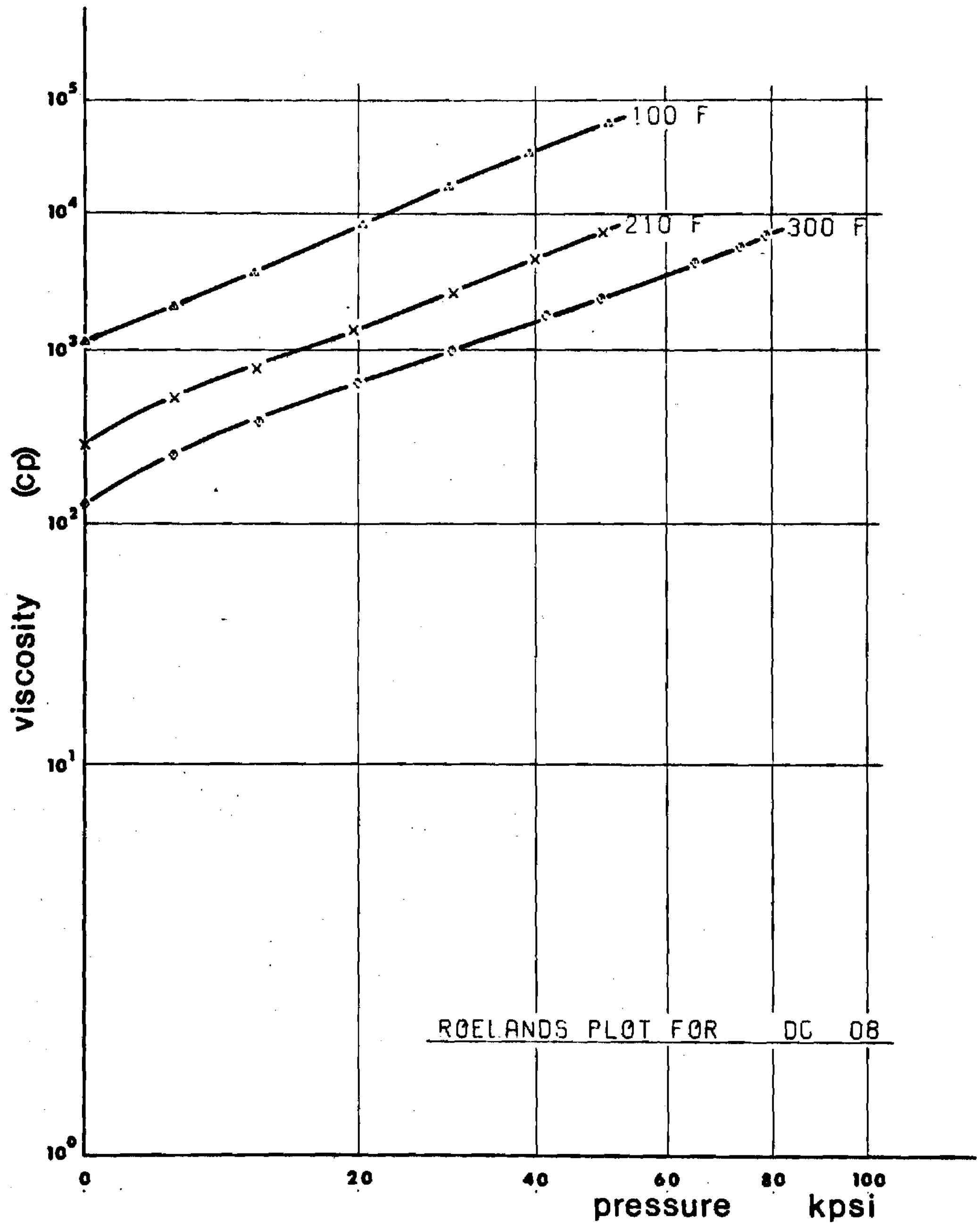

100 F
210 F
300 F
viscosity (cp)
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
0
20
40
60
80
100
pressure kpsi
ROELANDS PLOT FOR DC 08

Figure 2-8

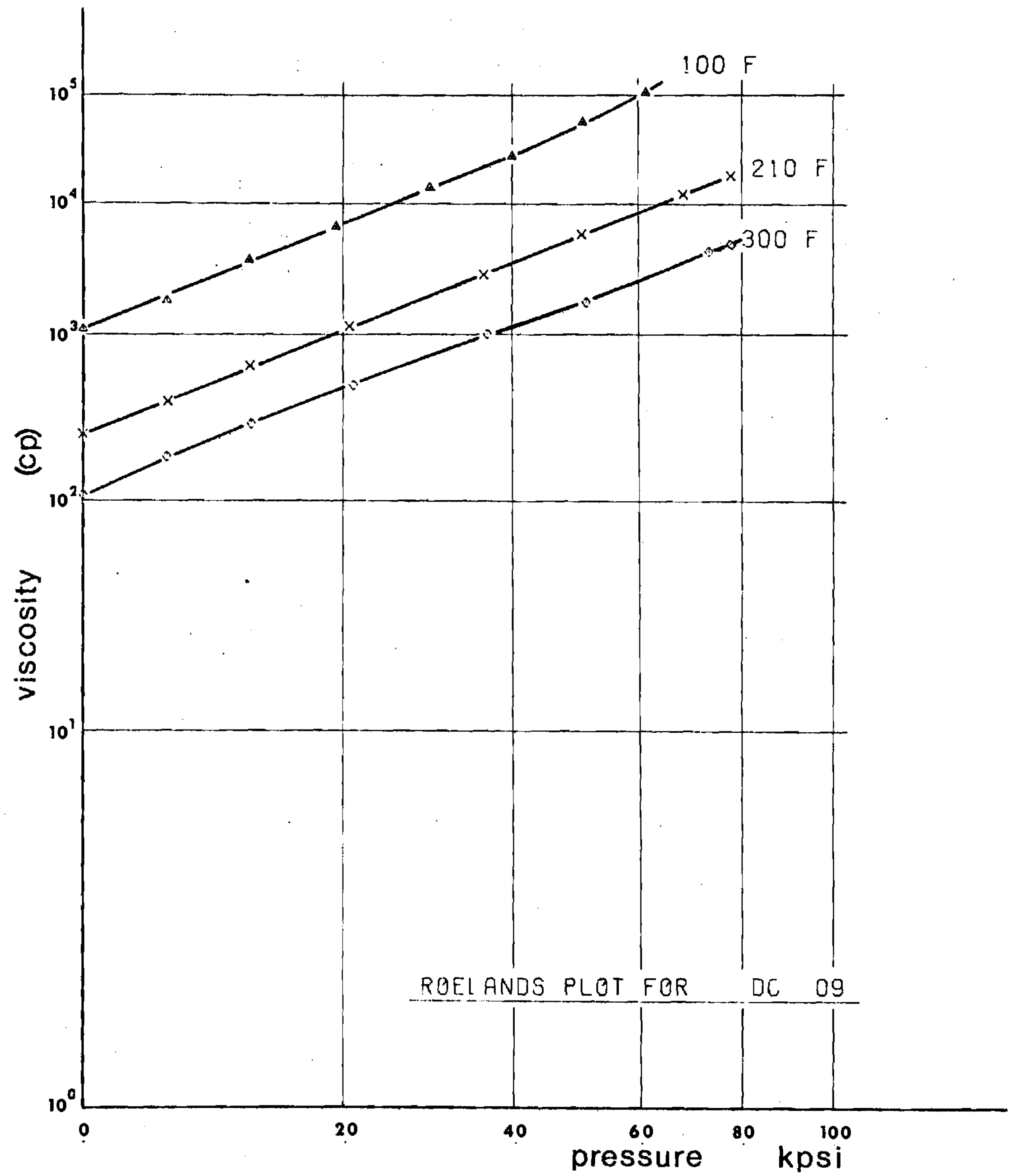
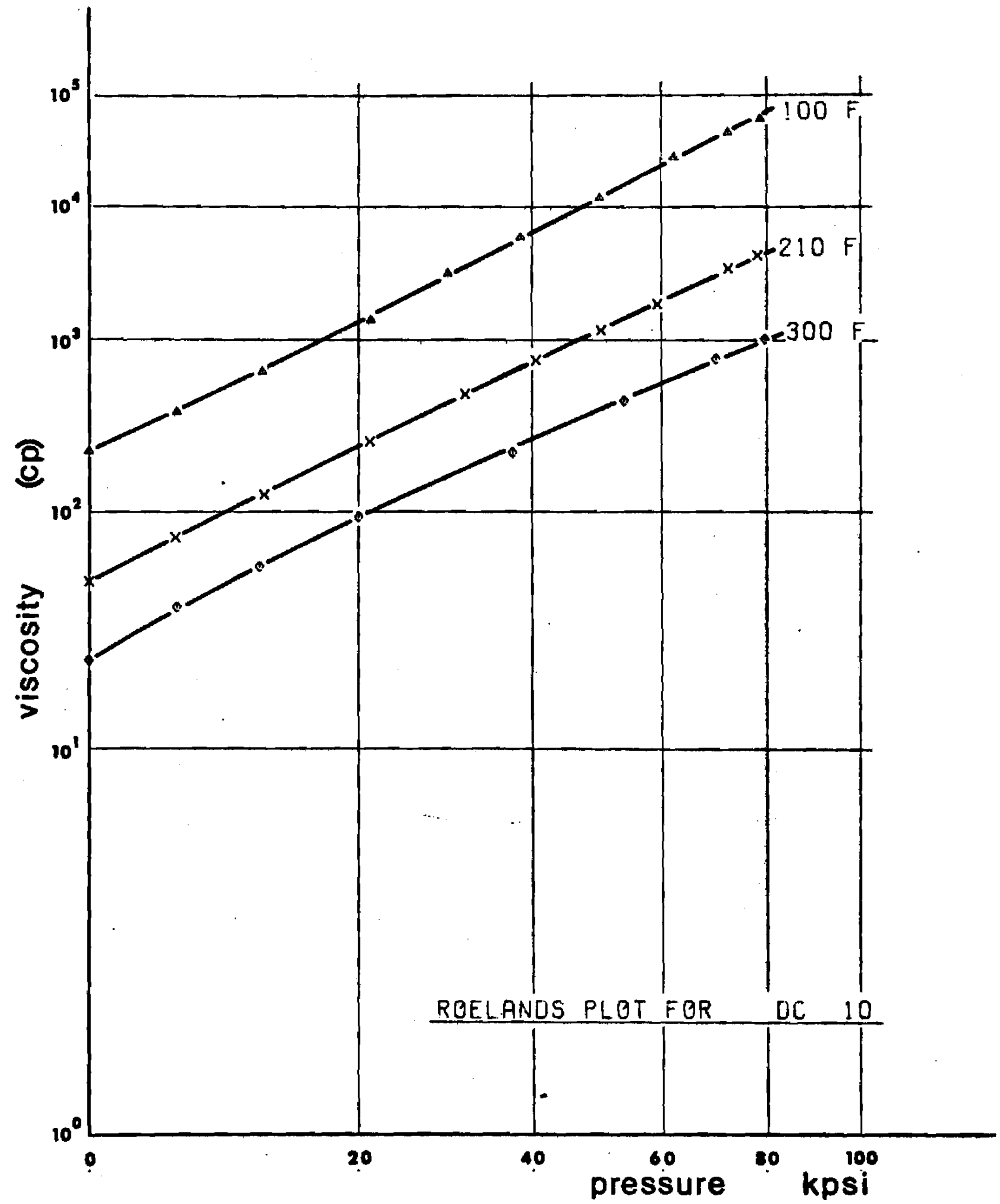
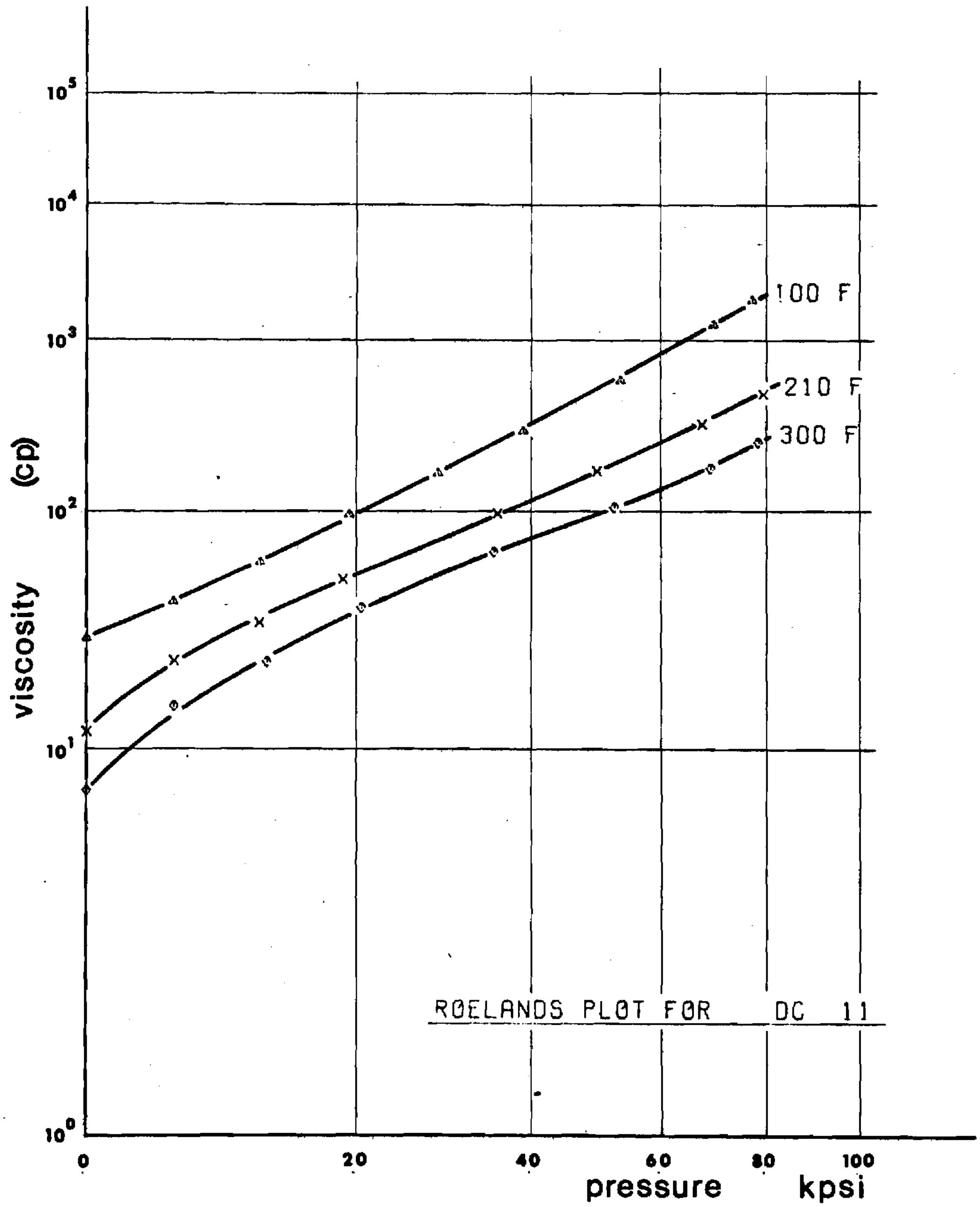

100 F
210 F
300 F
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
viscosity (cp)
ROELANDS PLOT FOR DC 09
0
20
40
60
80
100
pressure kpsi

Figure 2-9



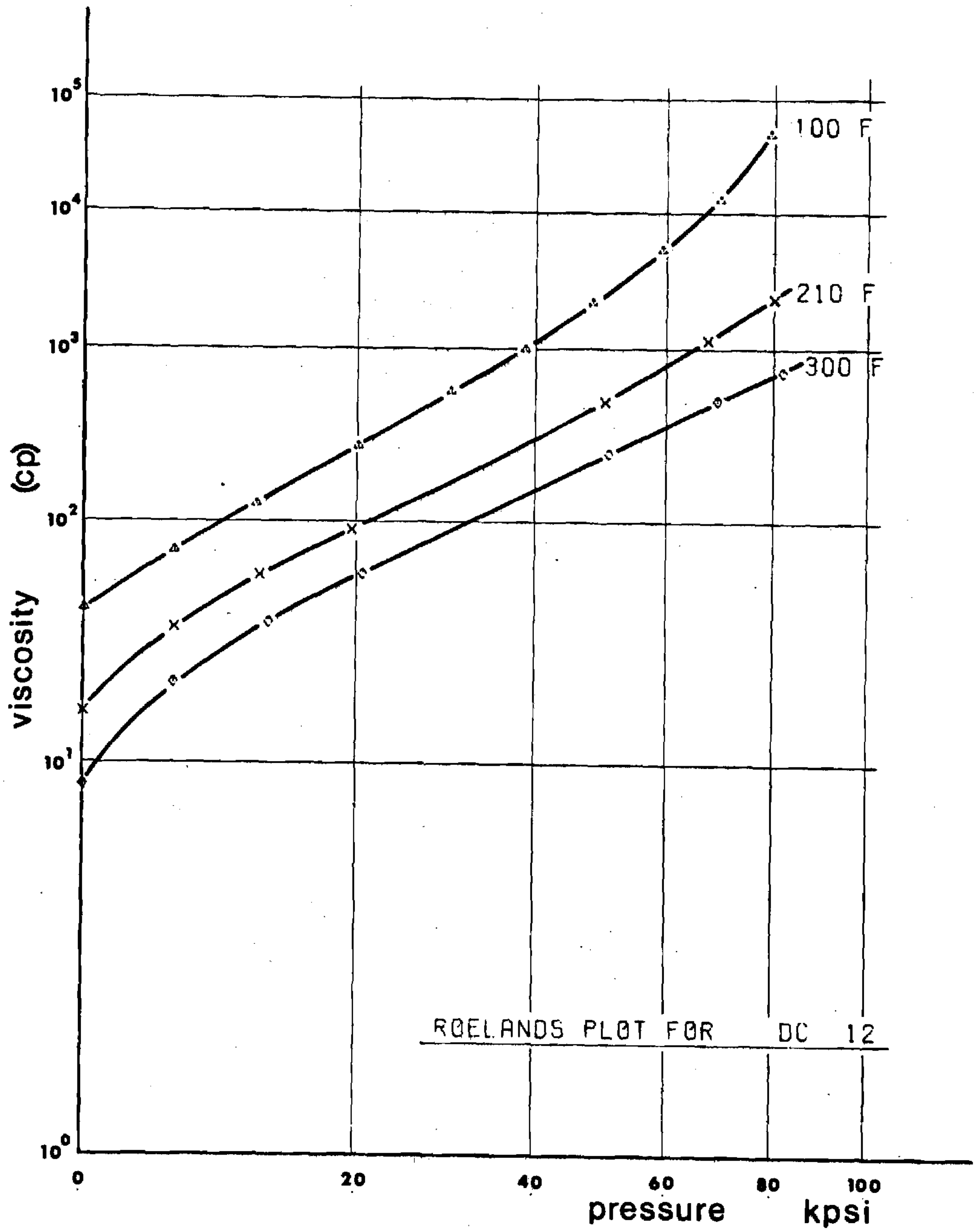
10^5
10^4
10^3
10^2
10^1
10^0
viscosity (cp)
100 F
210 F
300 F
ROELANDS PLOT FOR DC 10
0
20
40
60
80
100
pressure kpsi


Figure 2-10



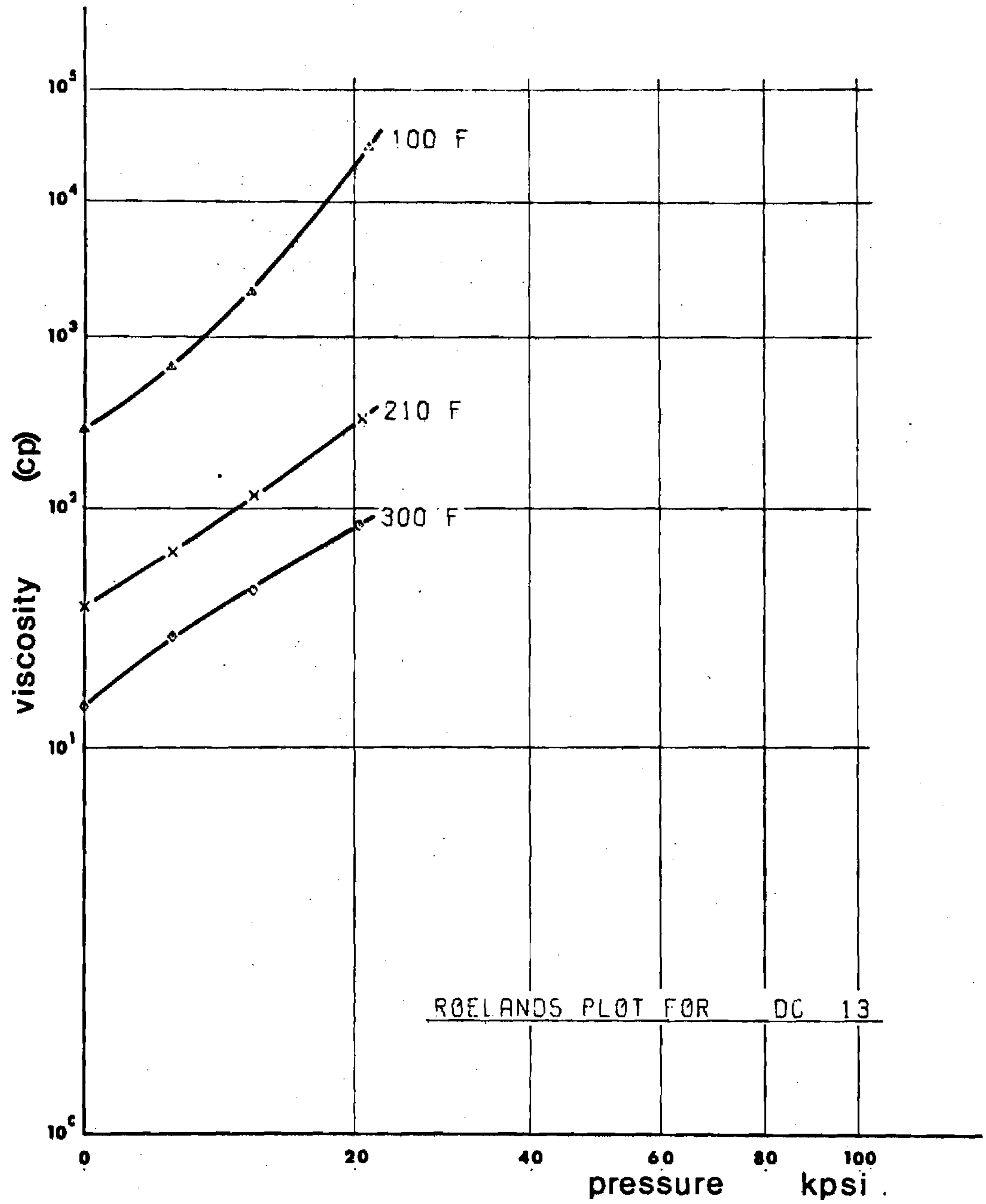
10^5
10^4
10^3
10^2
10^1
10^0
viscosity (cp)
100 F
210 F
300 F
ROELANDS PLOT FOR DC 11
0
20
40
60
80
100
pressure kpsi


Figure 2-11



10^5
10^4
10^3
10^2
10^1
10^0
viscosity (cp)
100 F
210 F
300 F
ROELANDS PLOT FOR DC 12
0
20
40
60
80
100
pressure kpsi


Figure 2-12



$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
viscosity (cp)
100 F
210 F
300 F
ROELANDS PLOT FOR DC 13
0
20
40
60
80
100
pressure kpsi


Figure 2-13

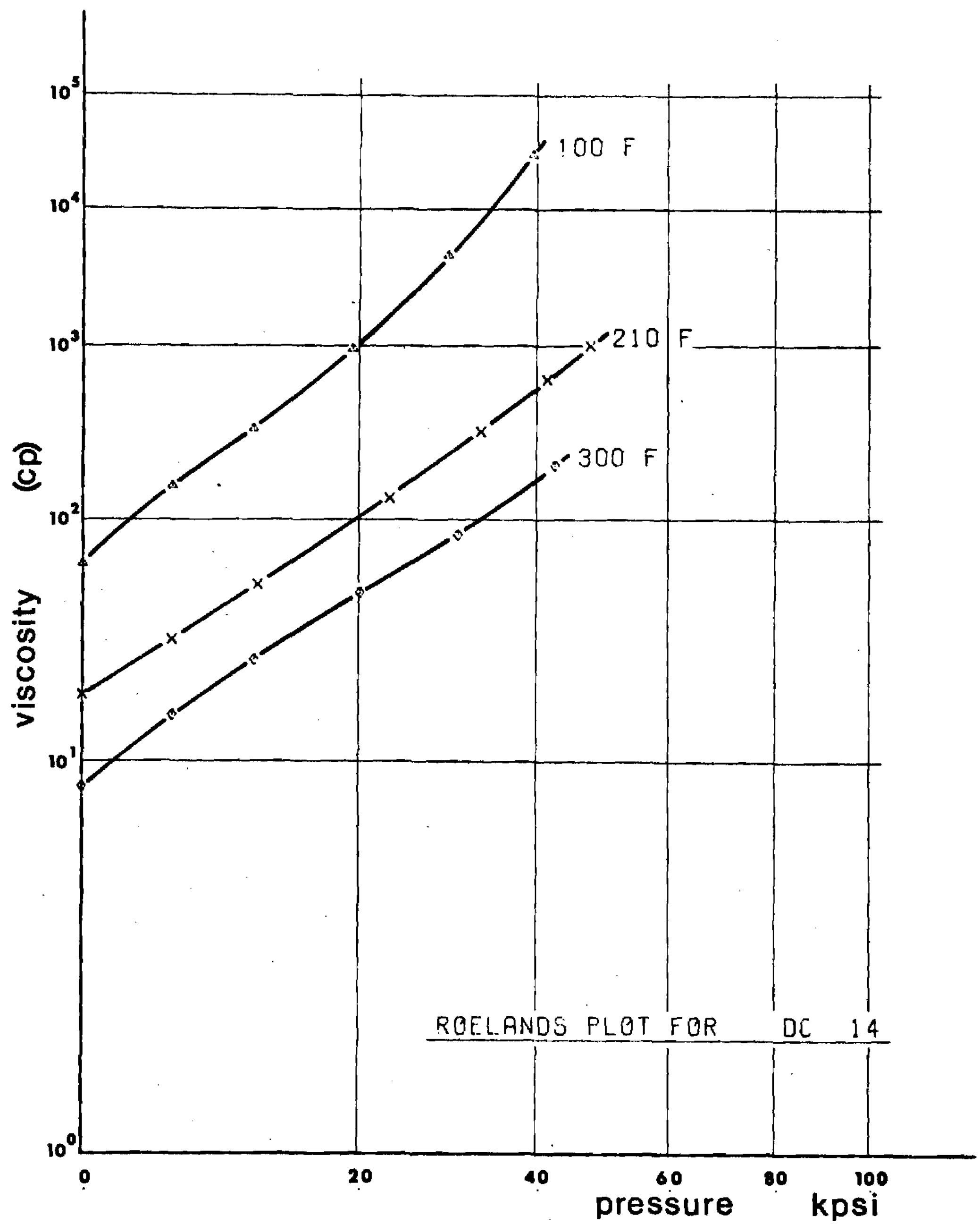
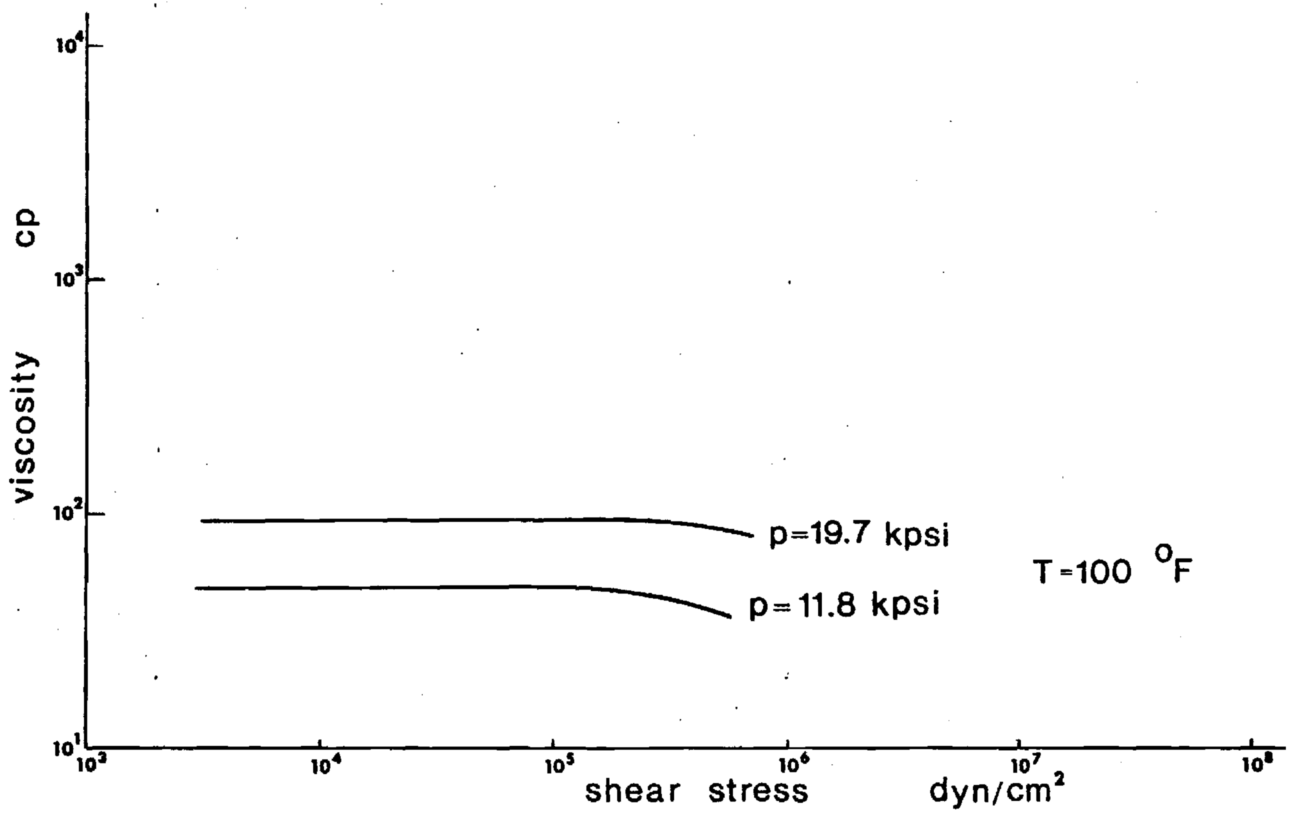
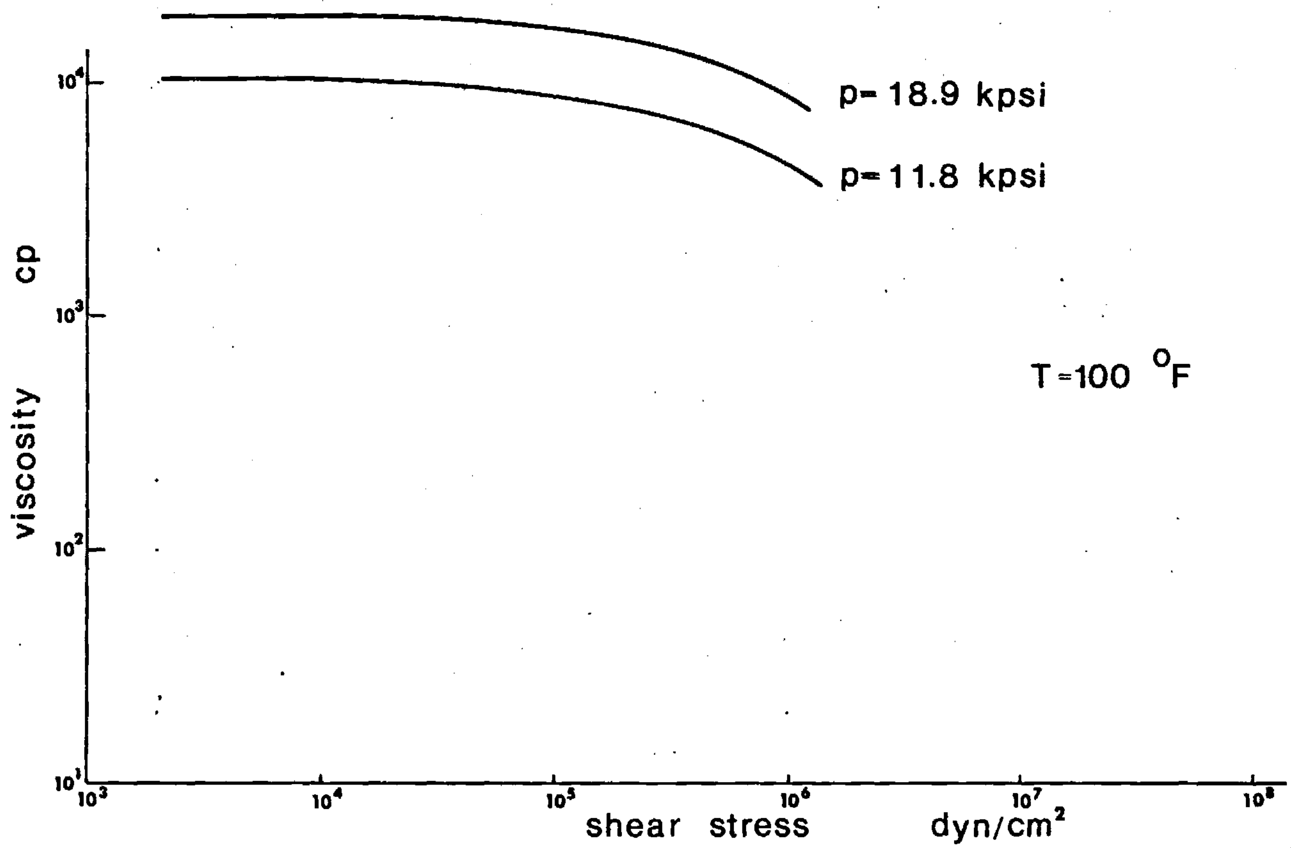

viscosity (cp)
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
100 F
210 F
300 F
ROELANDS PLOT FOR DC 14
0
20
40
60
80
100
pressure kpsi

Figure 2-14



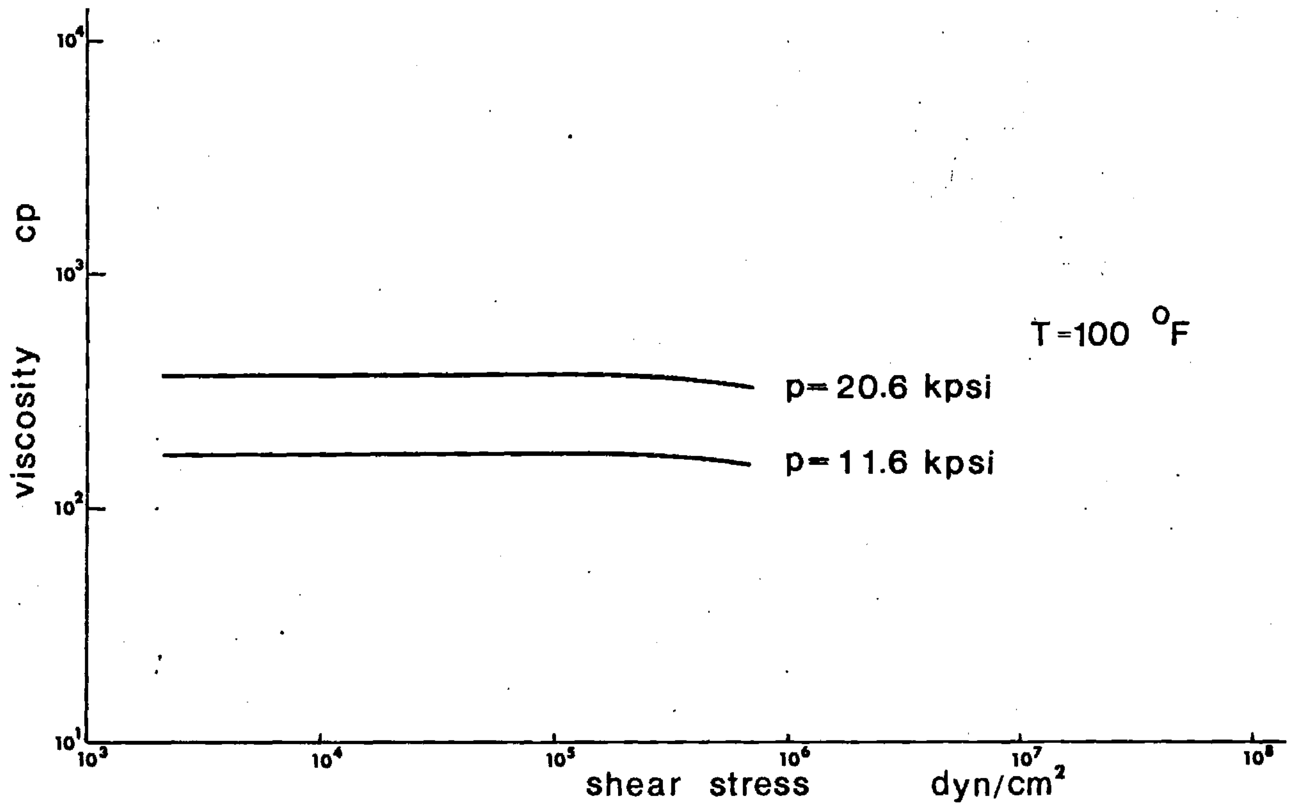

Viscosity-Shear Stress Relation for Fluid D.C.-01

Figure 3-1



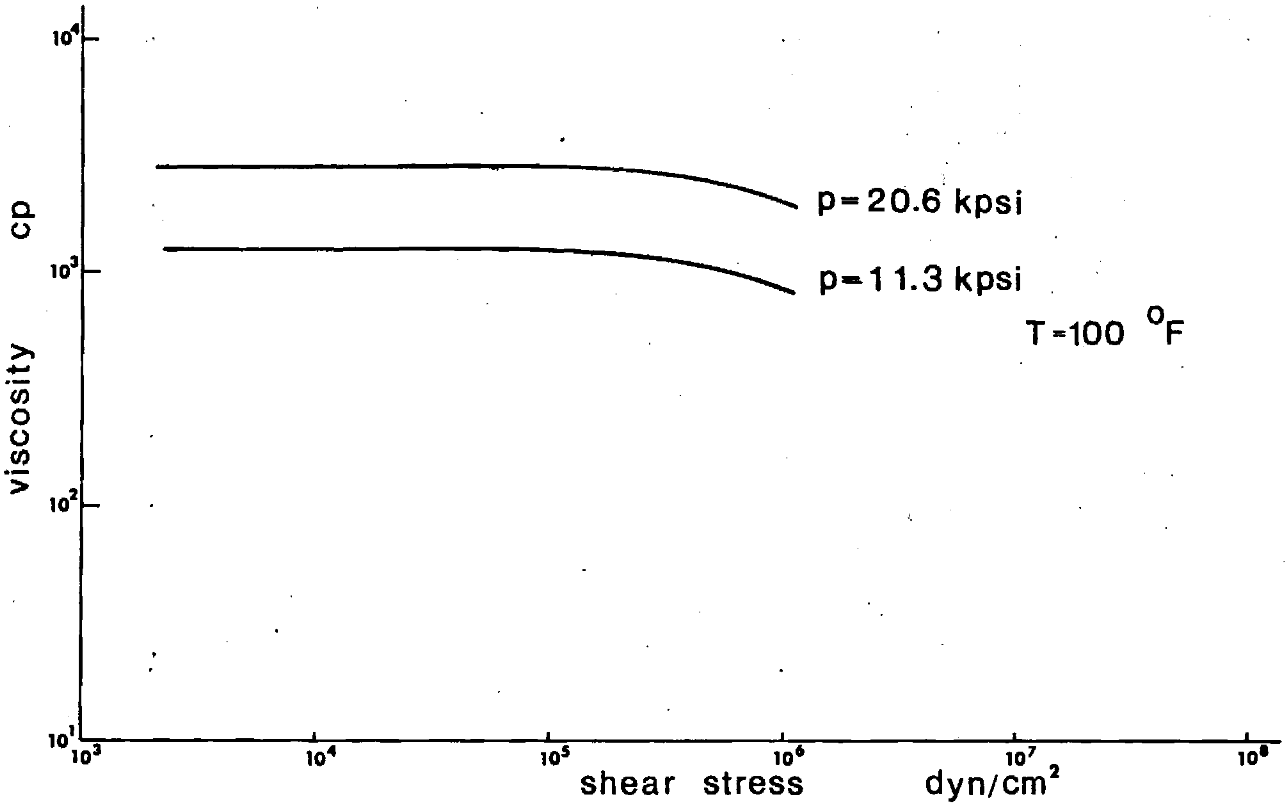

Viscosity-Shear Stress Relation for Fluid D.C.-02

Figure 3-2



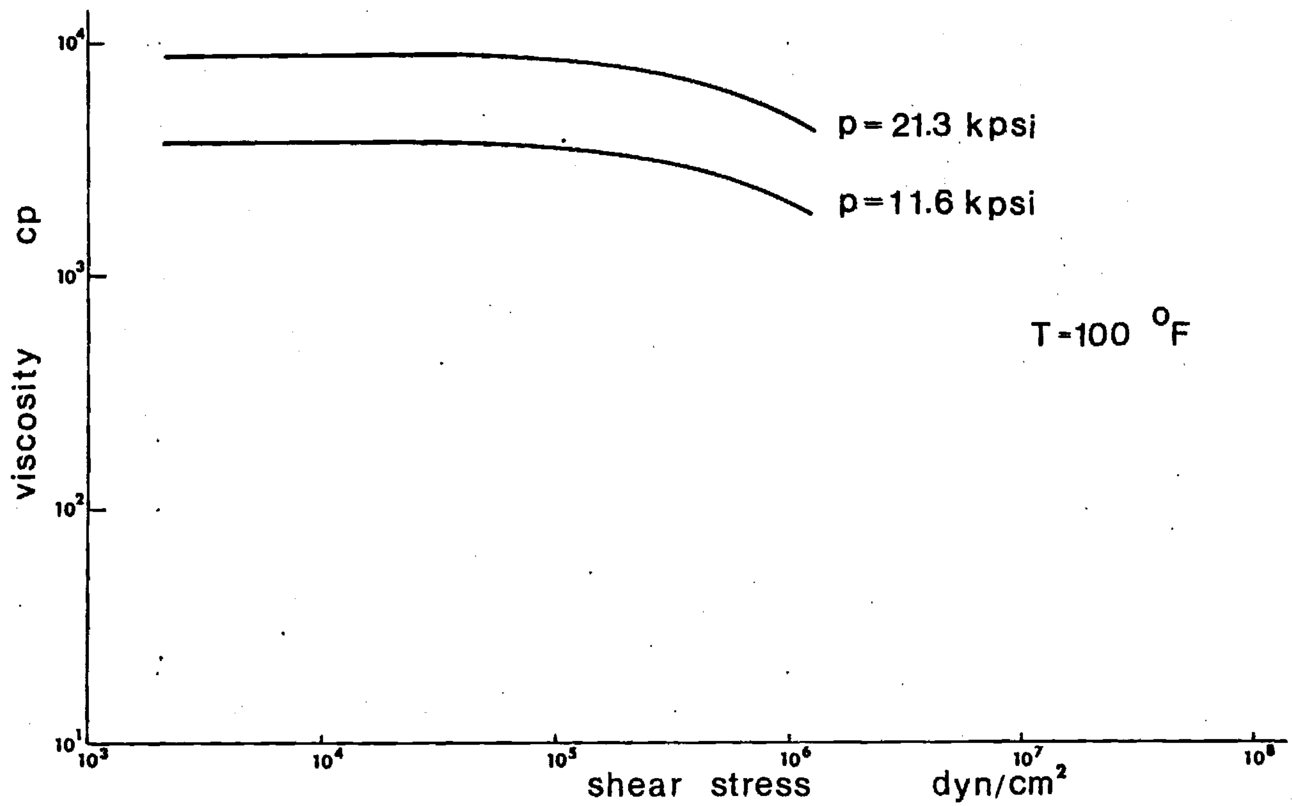

Viscosity-Shear Stress Relation for Fluid D.C.-03

Figure 3-3



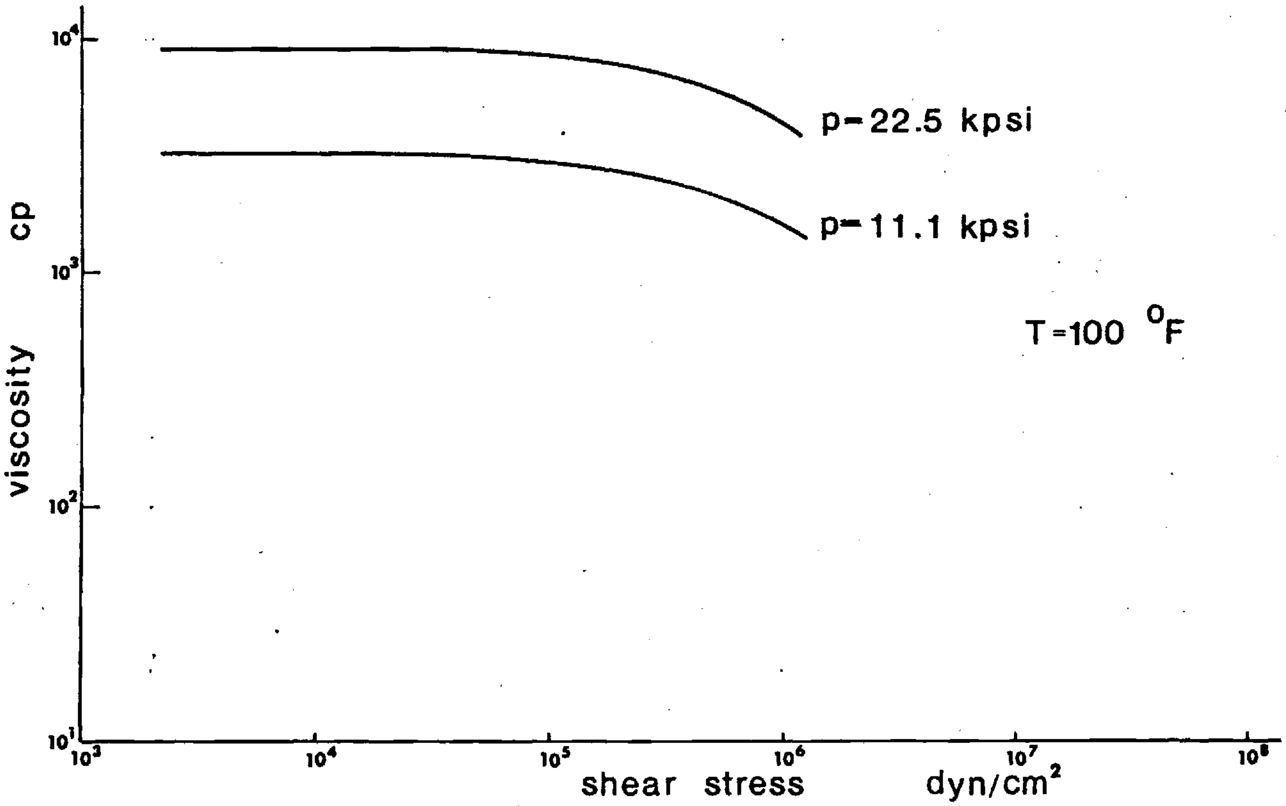

Viscosity-Shear Stress Relation for Fluid D.C.-04

Figure 3-4



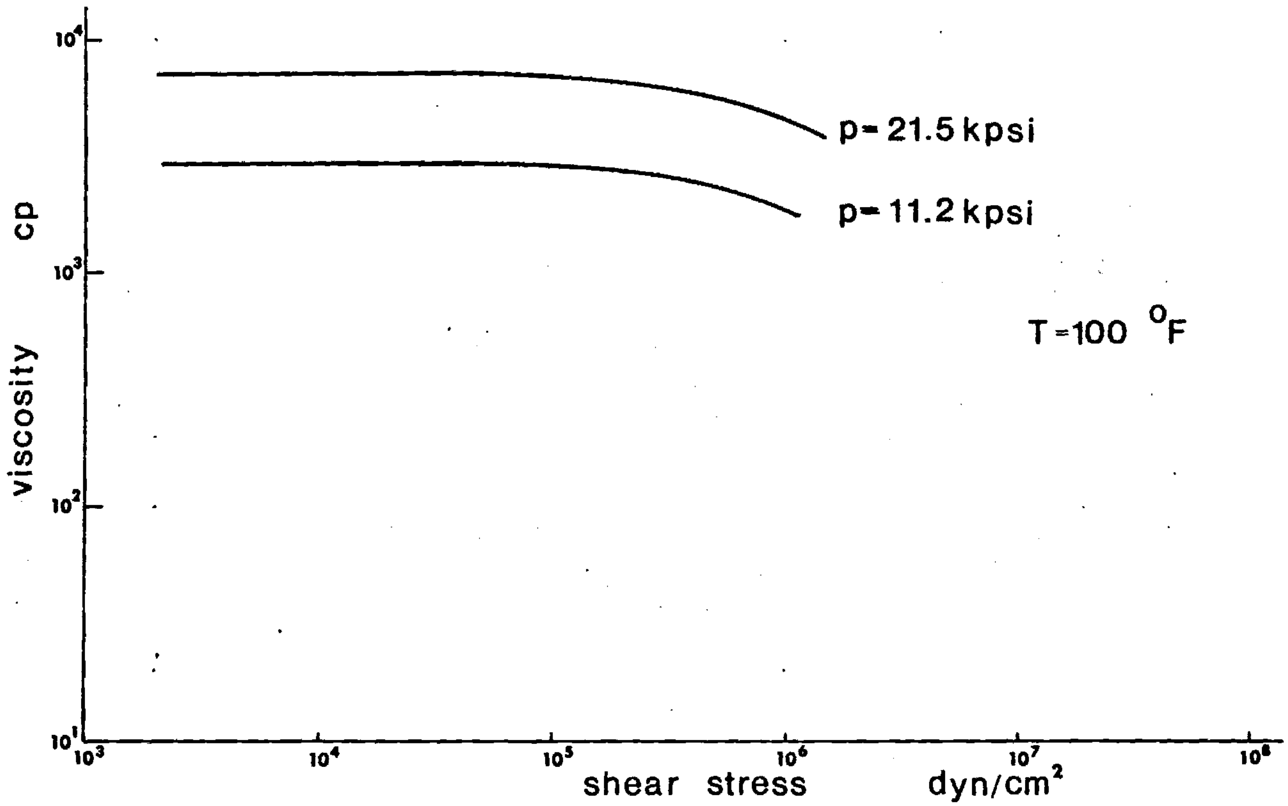

Viscosity-Shear Stress Relation for Fluid D.C.-06

Figure 3-6



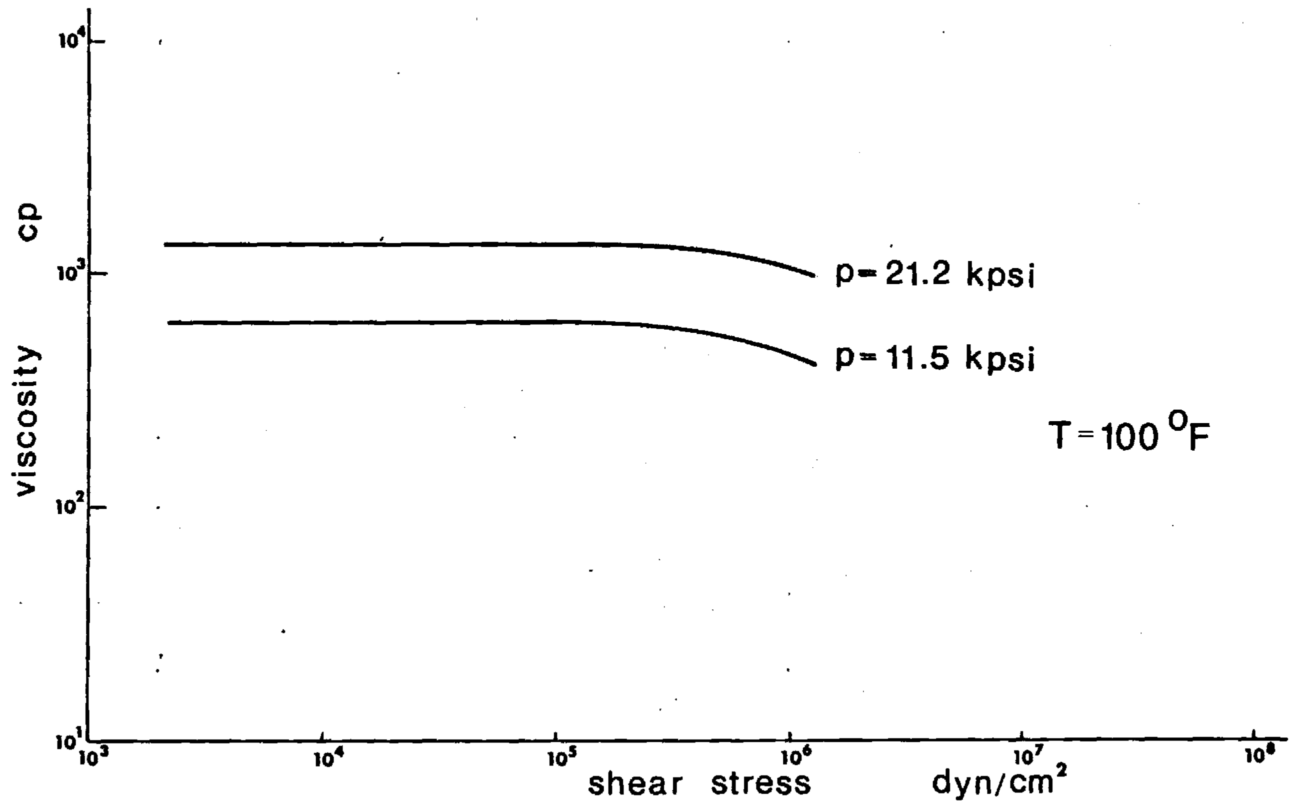

Viscosity-Shear Stress Relation for Fluid D.C.-08

Figure 3-8



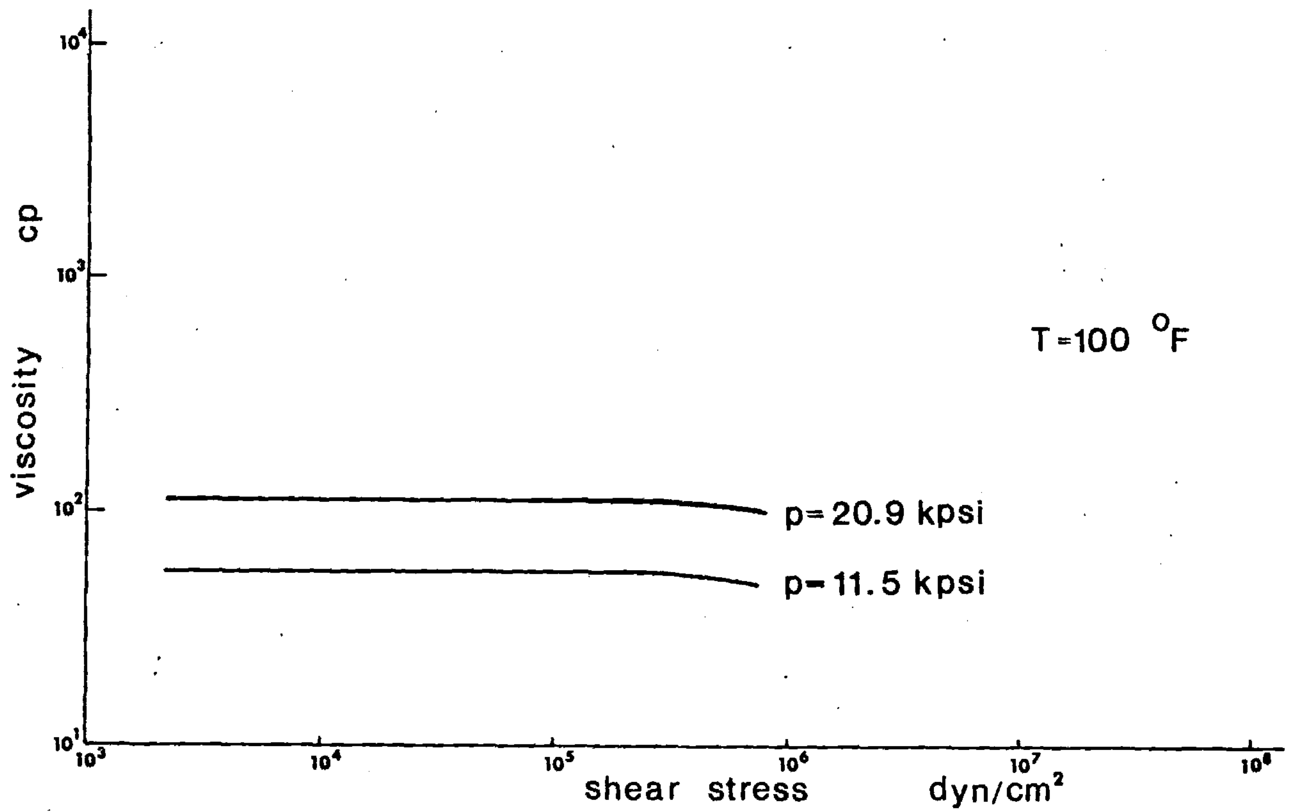

Viscosity-Shear Stress Relation for Fluid D.C.-09

Figure 3-9



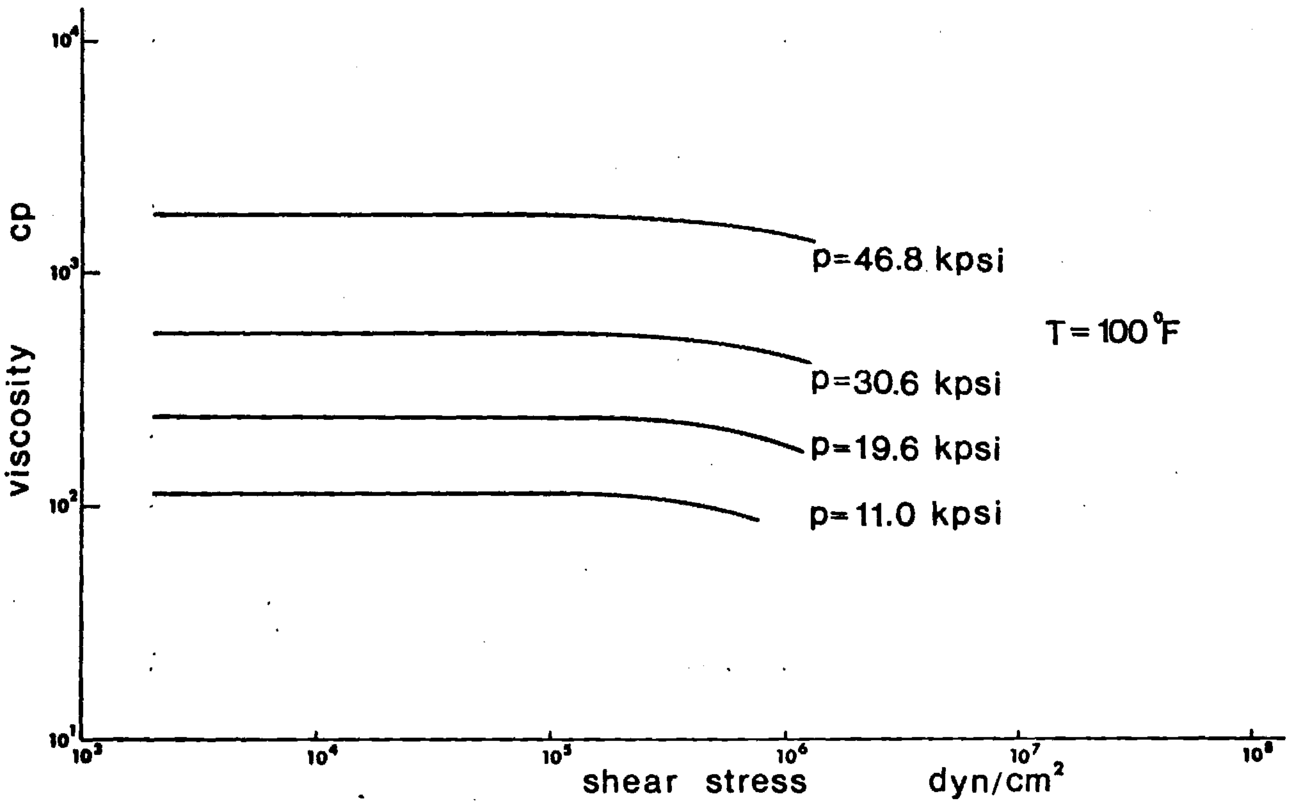

Viscosity-Shear Stress Relation for Fluid D.C.-10

Figure 3-10



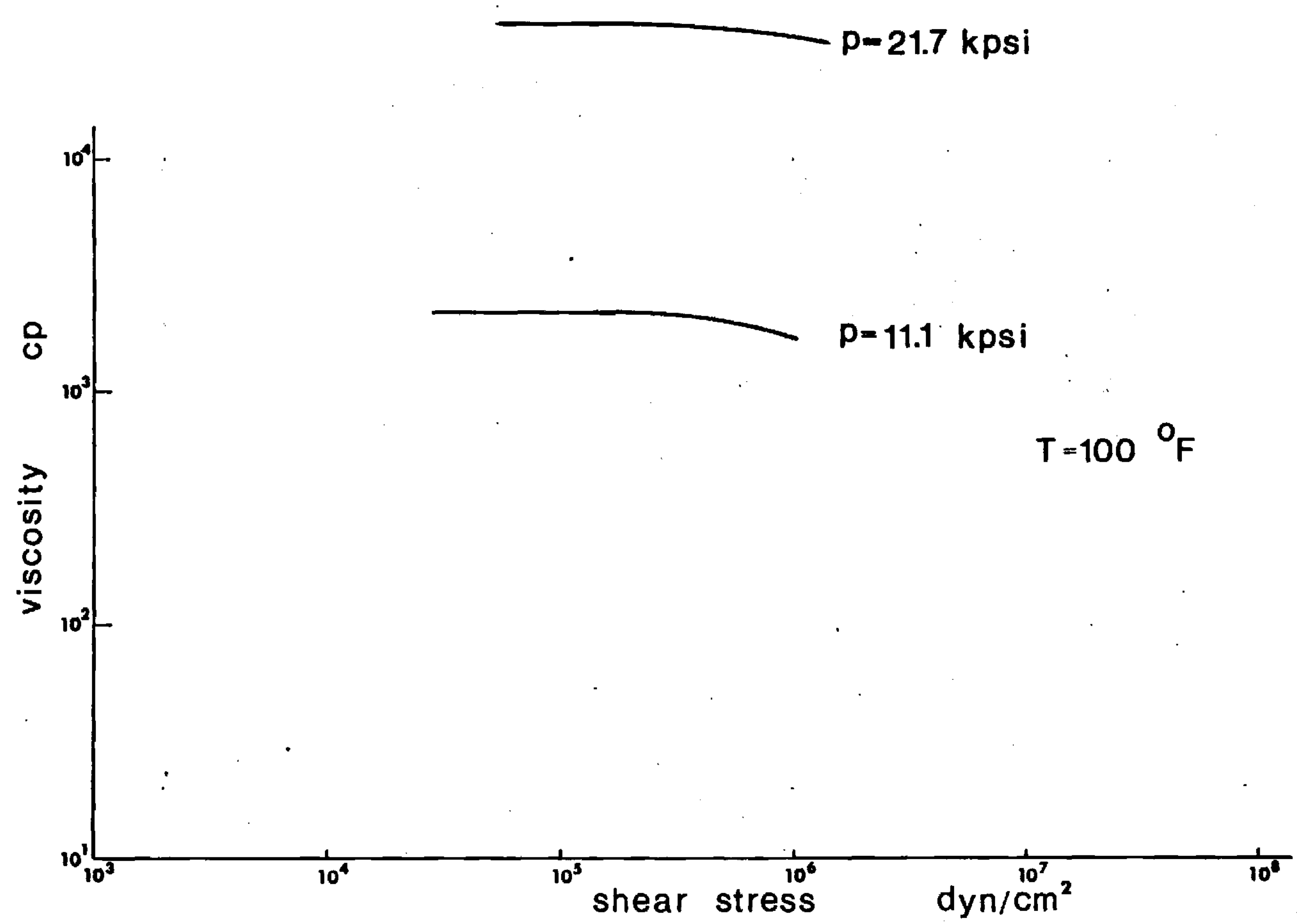

Viscosity-Shear Stress Relation for Fluid D.C.-11

Figure 3-11



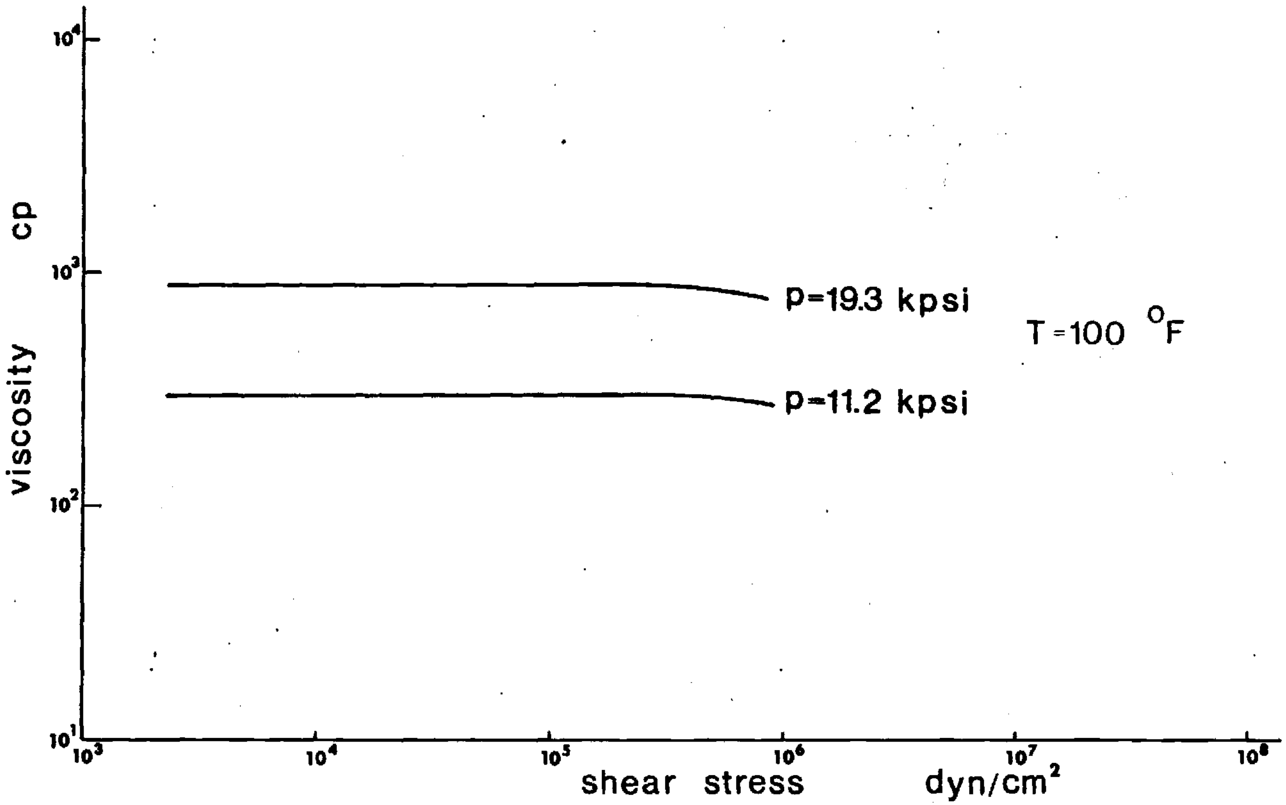

Viscosity-Shear Stress Relation for Fluid D.C.-12

Figure 3-12




Viscosity-Shear Stress Relation for Fluid D.C.-13

Figure 3-13




Viscosity-Shear Stress Relation for Fluid D.C.-14

Figure 3-14

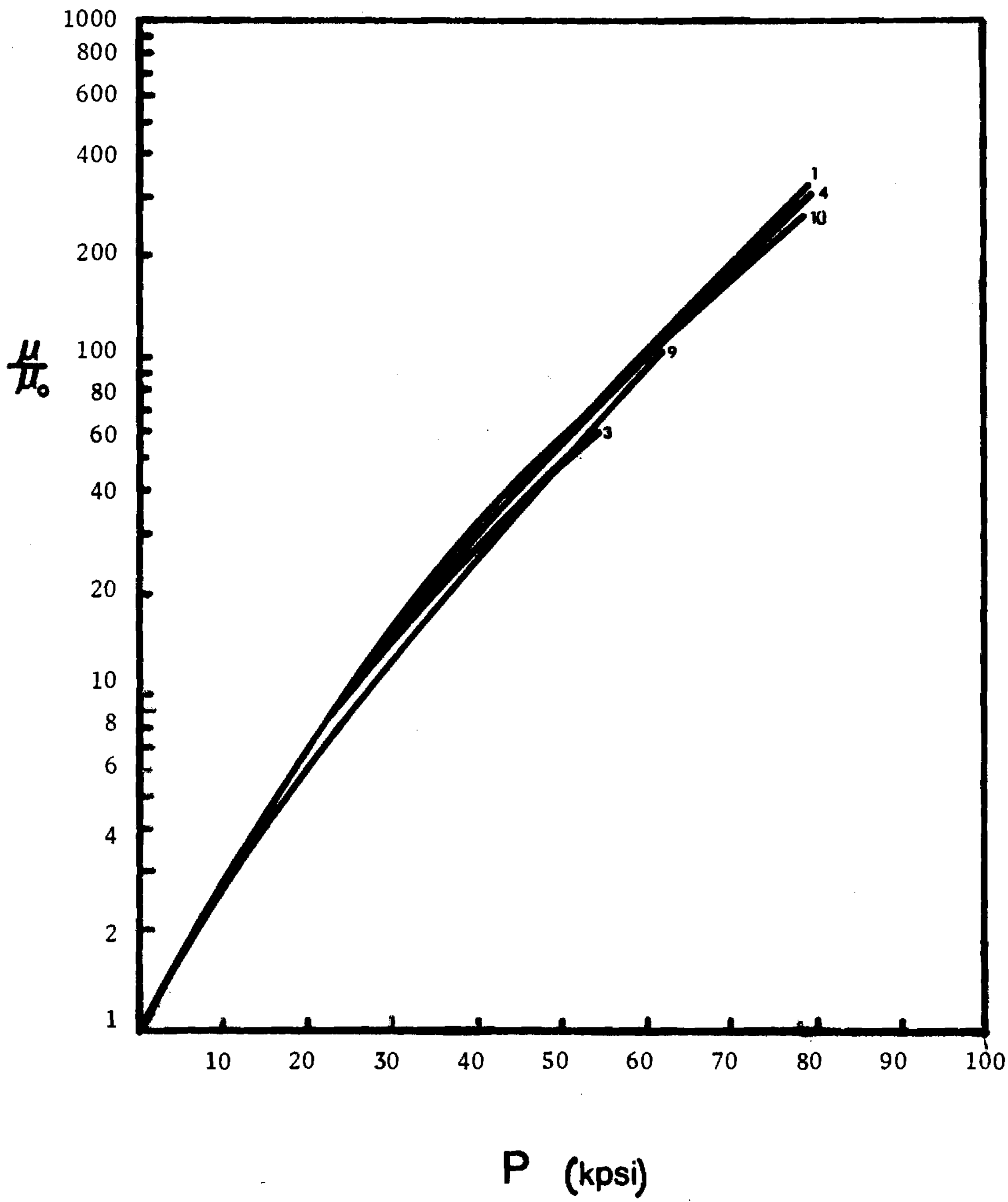



**Figure 4A** Reduced Viscosity Pressure Isotherms for Octamethyl Fluids (1,3,4,9,10) at 100F

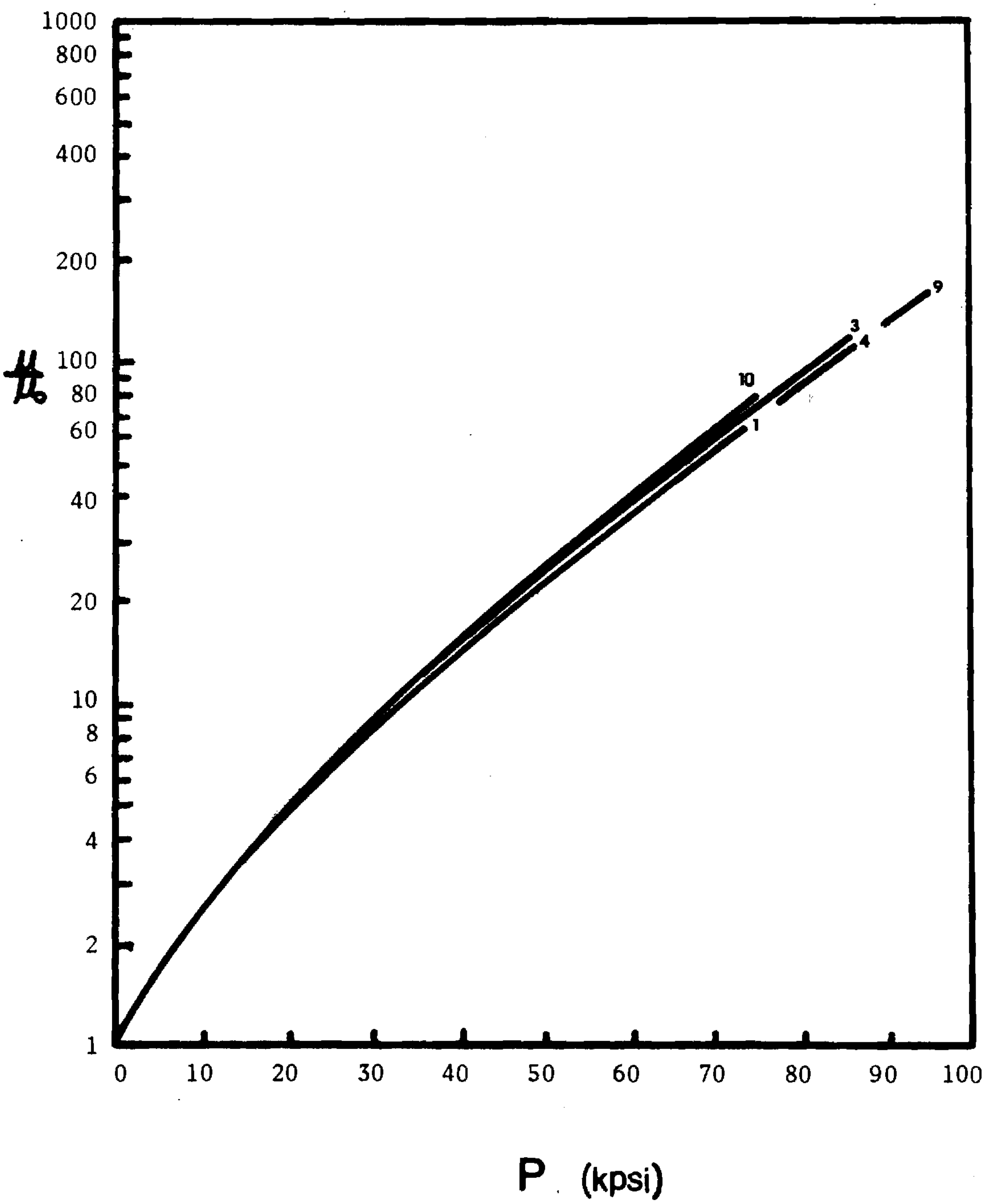



Figure 4B Reduced Viscosity-Pressure Isotherms for Octamethyl Fluids (1,3,4,9,10) at 210F

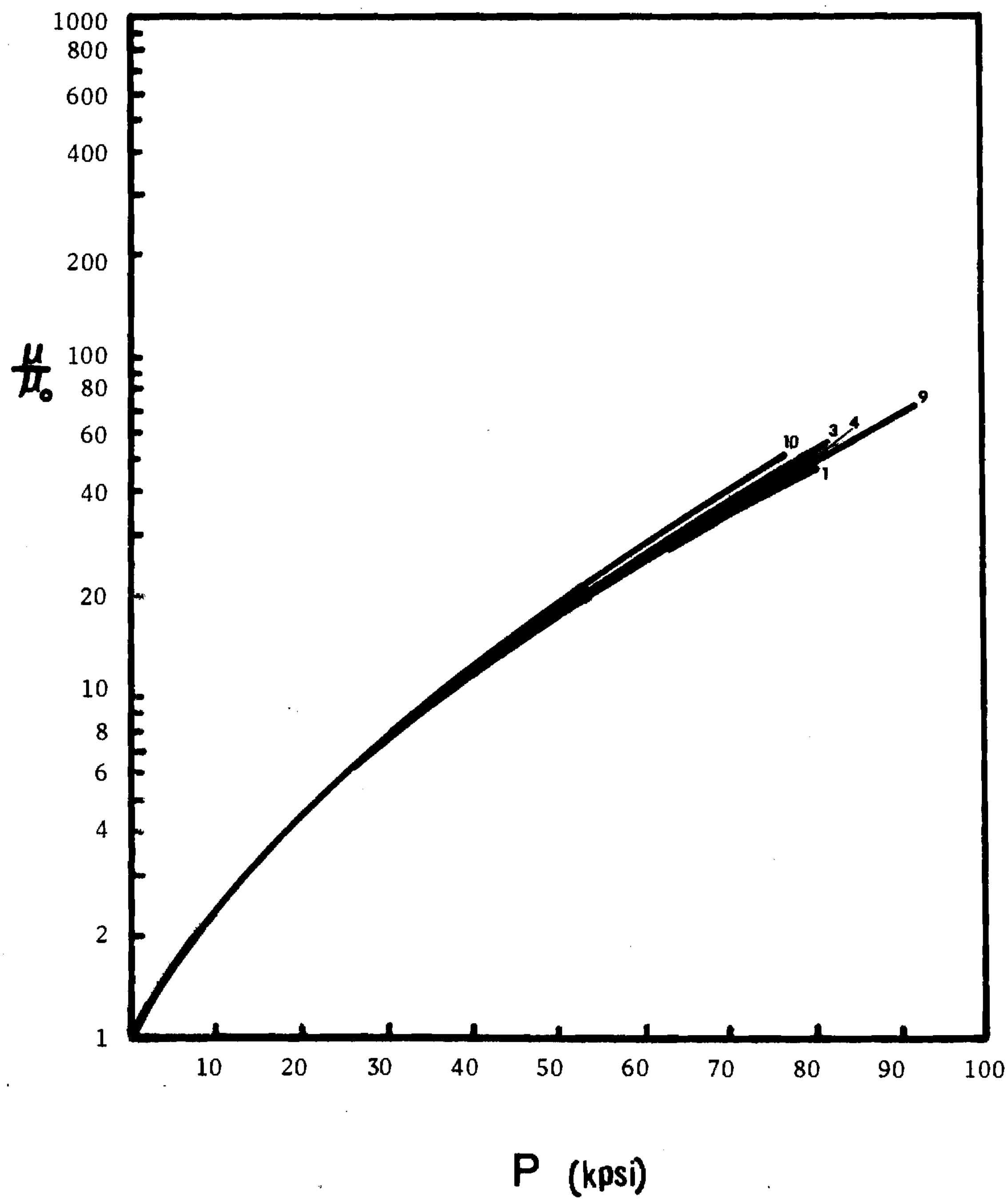



Figure 4C Reduced Viscosity-Pressure Isotherms for Octamethyl Fluids (1,3,4,9,10) at 300F

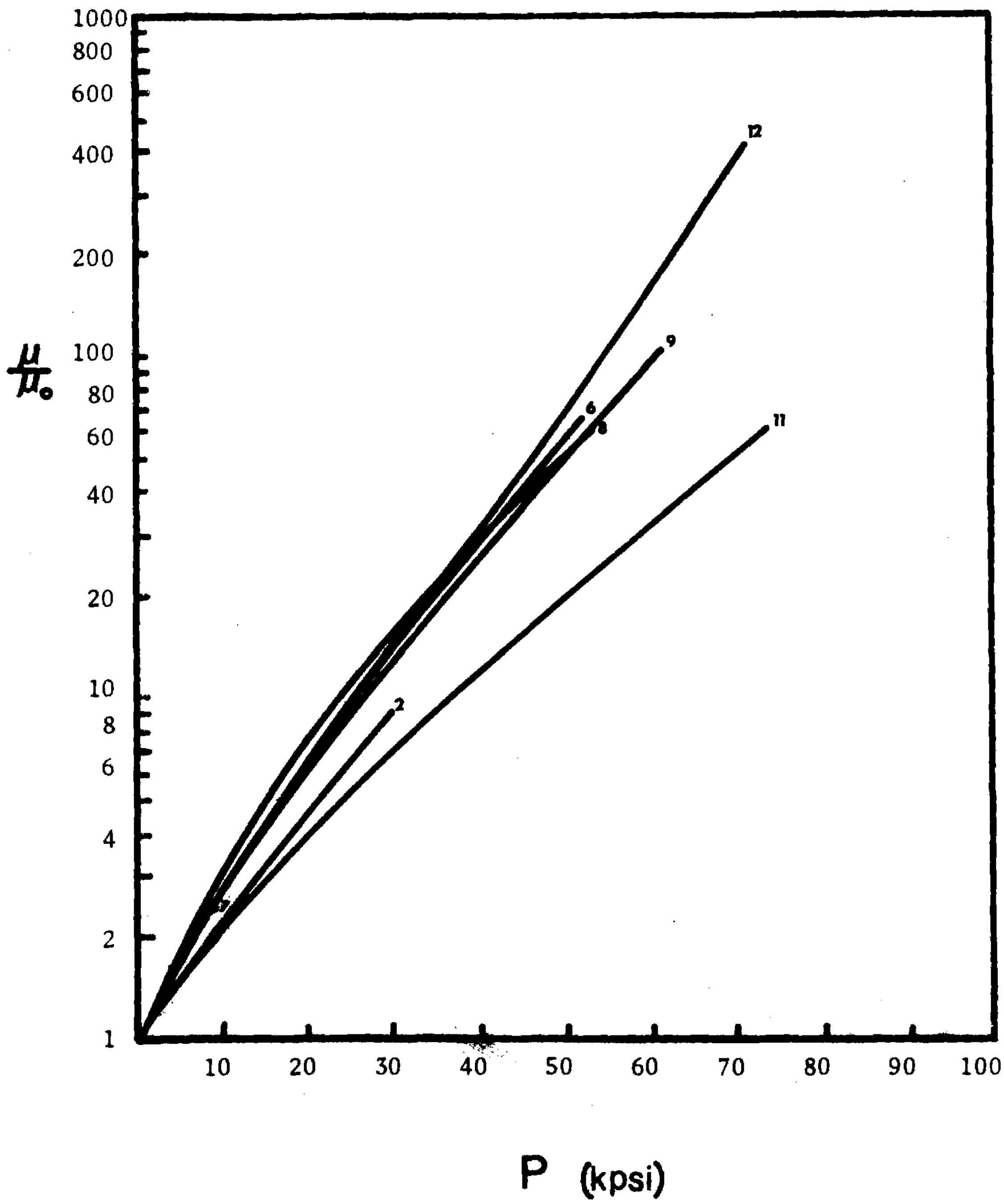



Figure 5A Reduced Viscosity Pressure Isotherms for DP-35 Fluids (2,6,7,8,9,11,12) at 100F

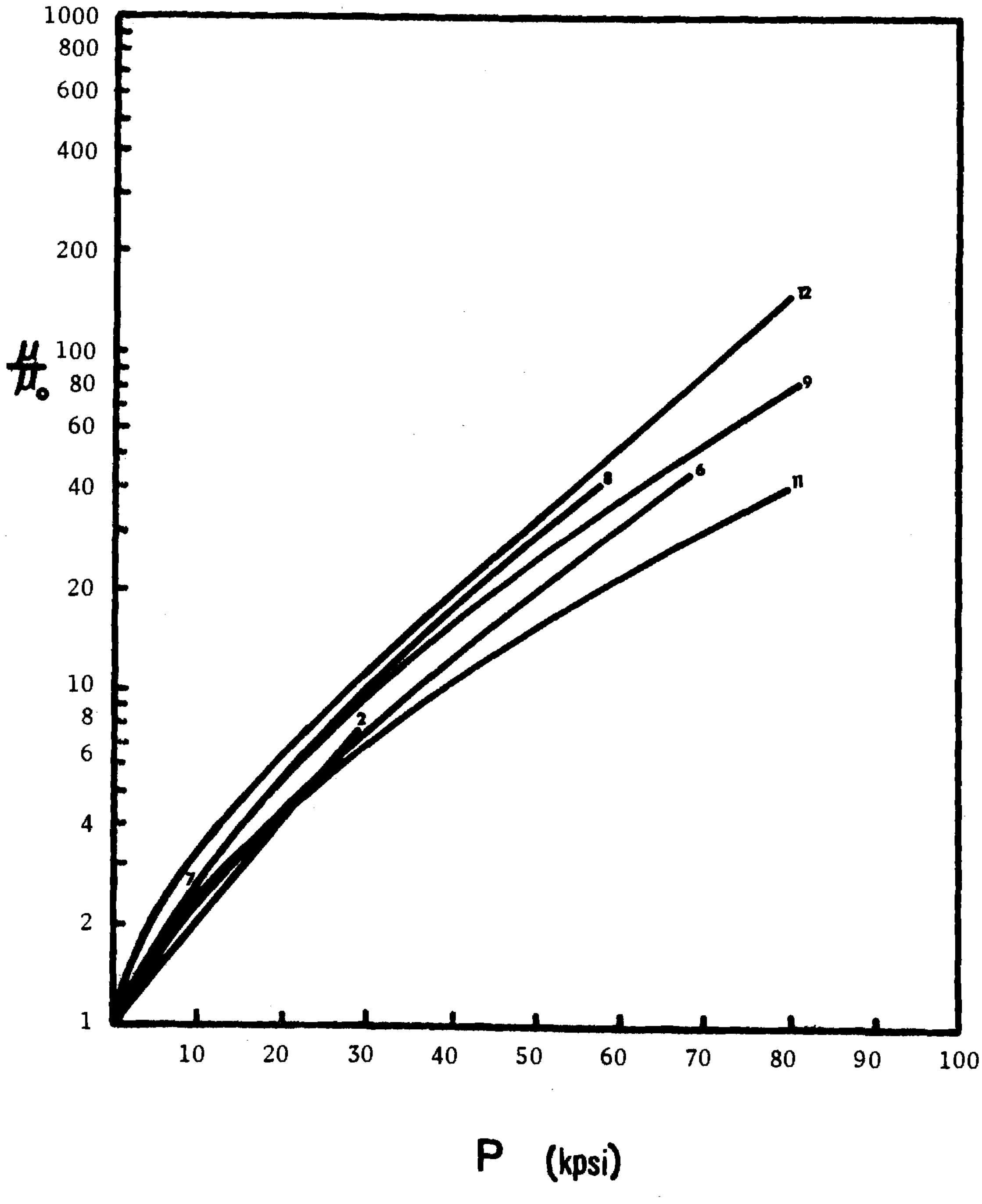



Figure 5B Reduced Viscosity Pressure Isotherms for DP-35 Fluids (2,6,7,8,9,11,12) at 210F

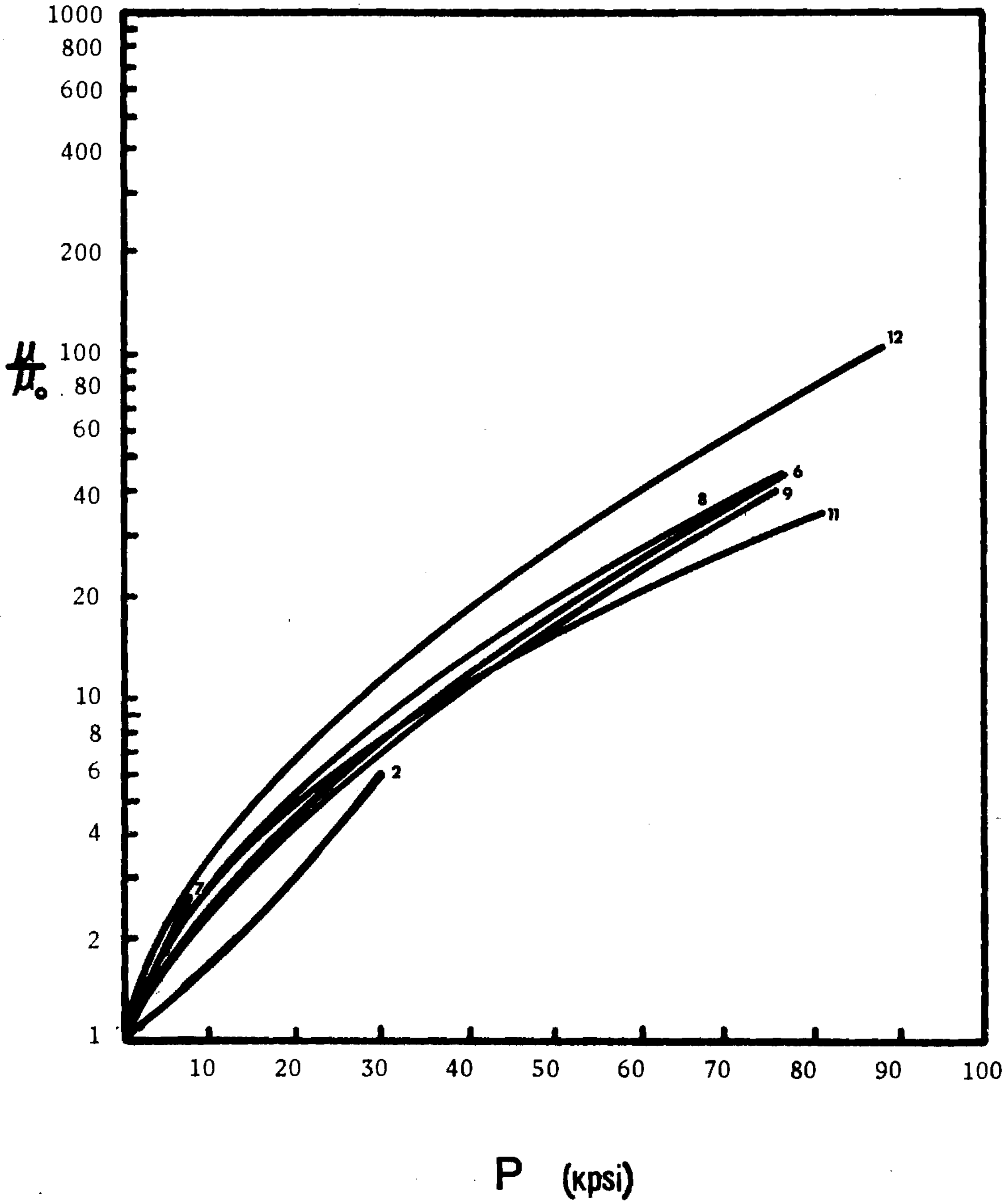



Figure 5C Reduced Viscosity Pressure Isotherms for DP-35 Fluids (2,6,7,8,9,11,12) at 300F

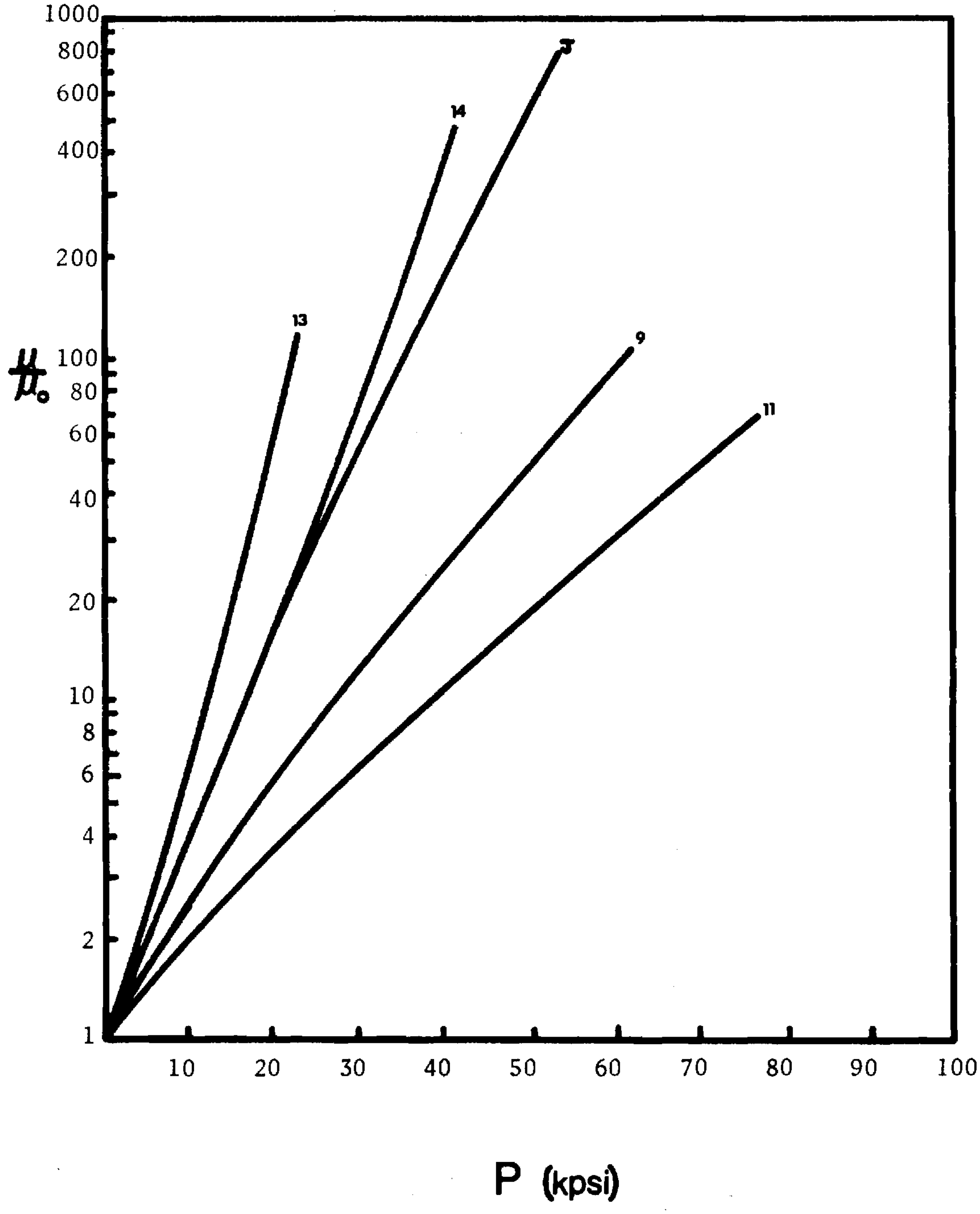



**Figure 6A Reduced Viscosity Pressure Isotherms for Fluids (9,11,13, 14, J) at 100F**

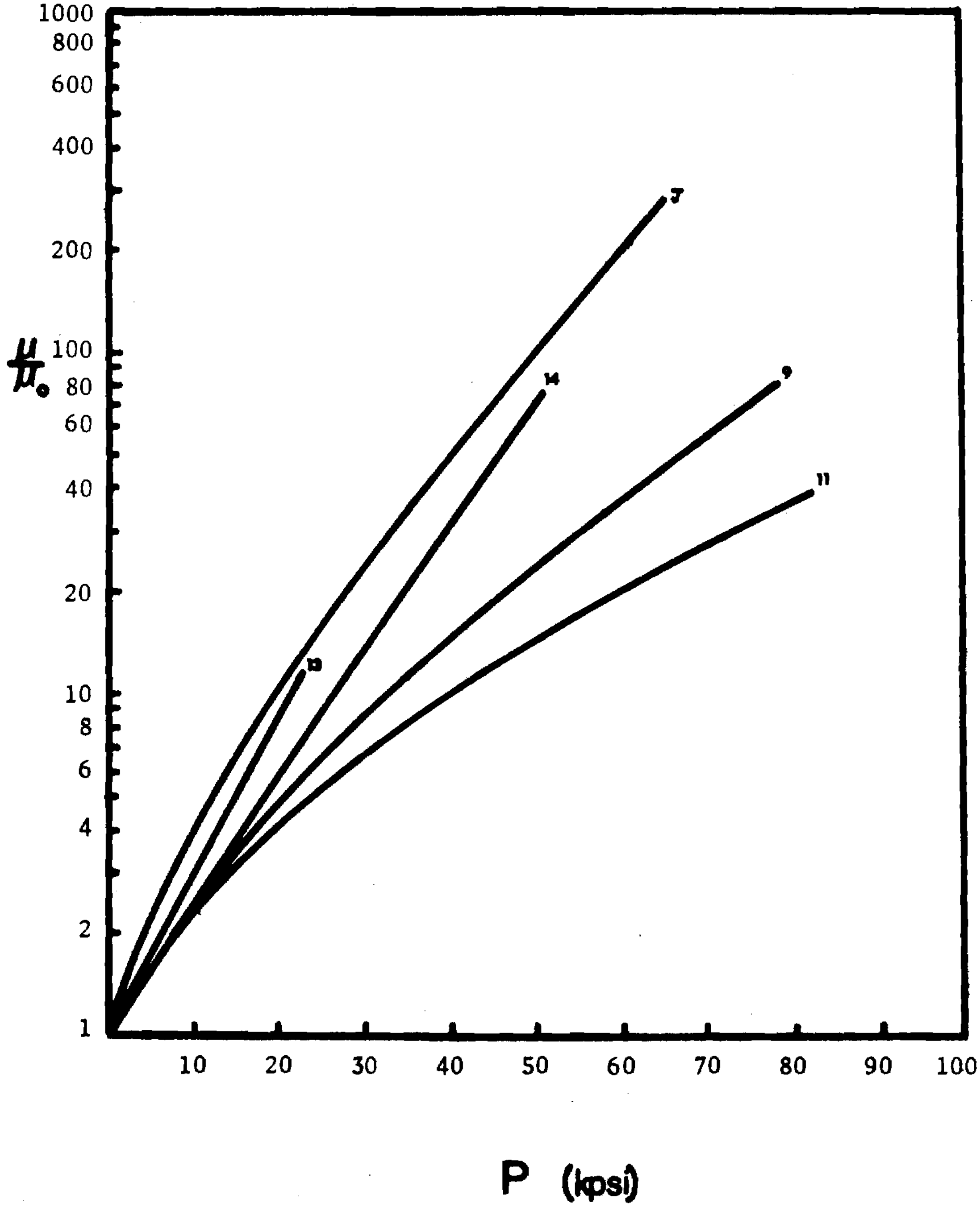



**Figure 6B Reduced Viscosity Pressure Isotherms for Fluids (9,11,13,14,J) at 210F**

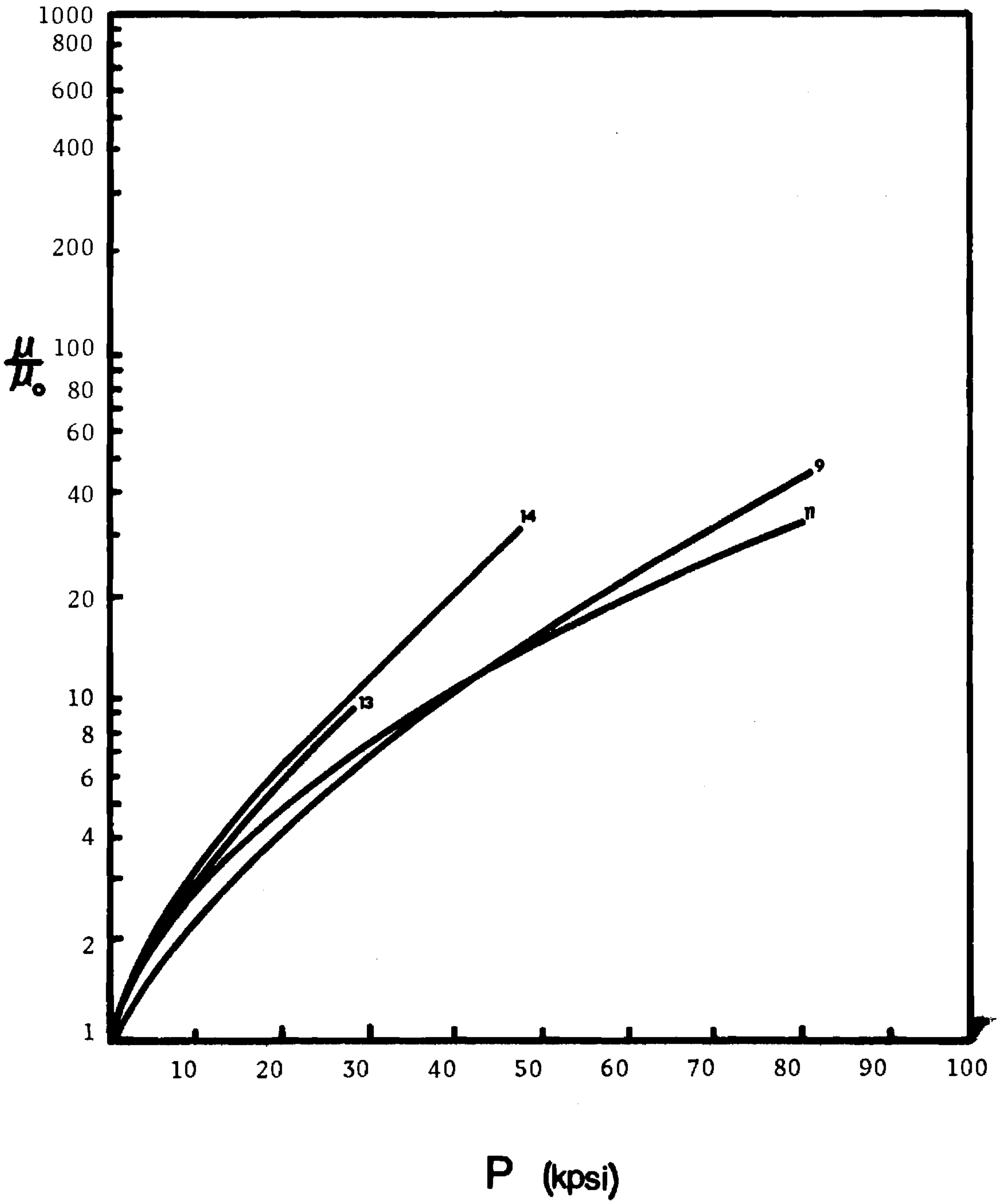



Figure 6C Reduced Viscosity Pressure Isotherms for Fluids (9,11,13,14) at 300F

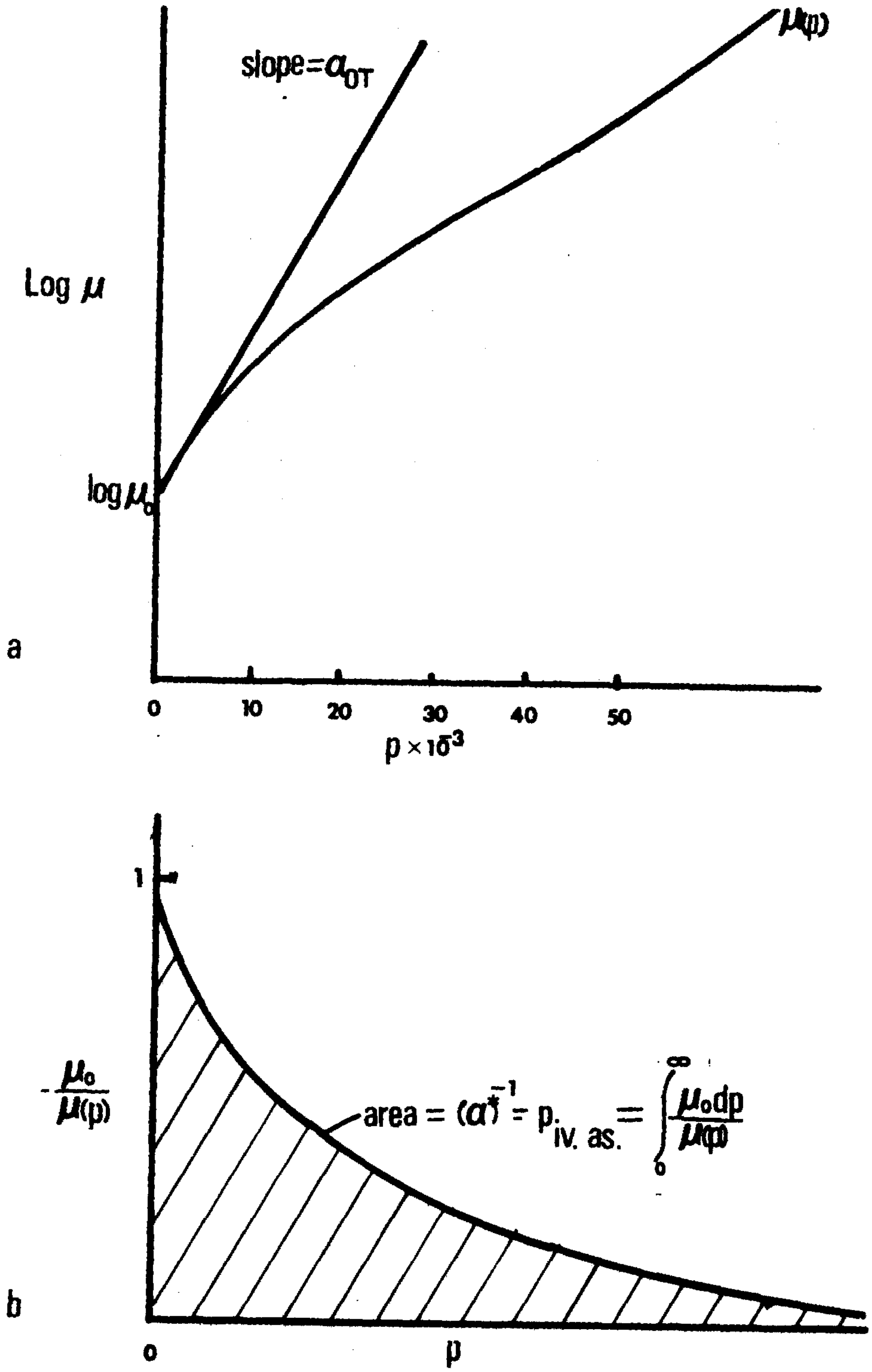



**Figure 7** Definition of Methods for Describing Pressure Viscosity Characteristics $\alpha_{oT}$, $\alpha^*$.

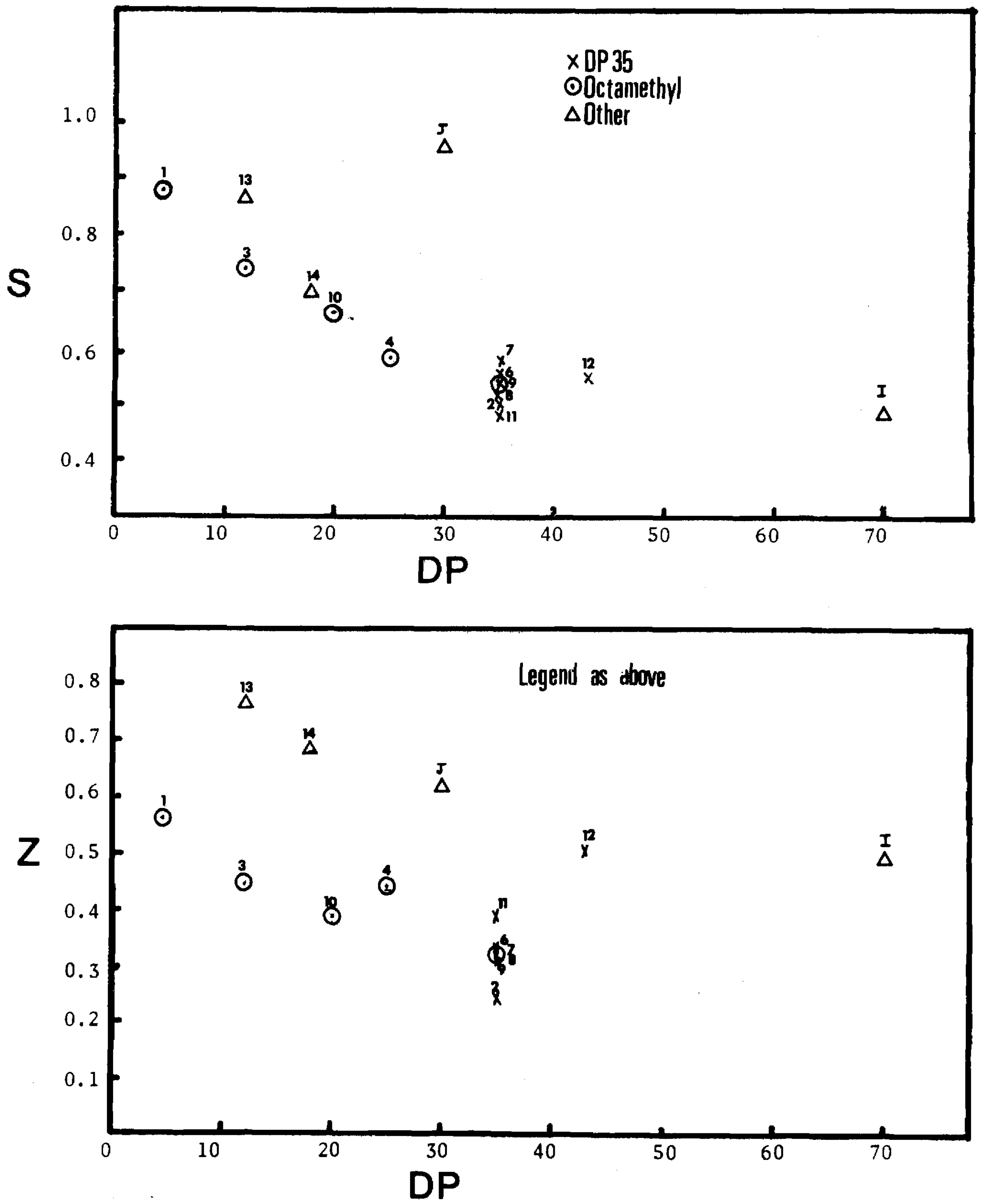



Figure 8  Roelands Pressure (Z) and Temperature (S) Slope Indices as a Function of DP.

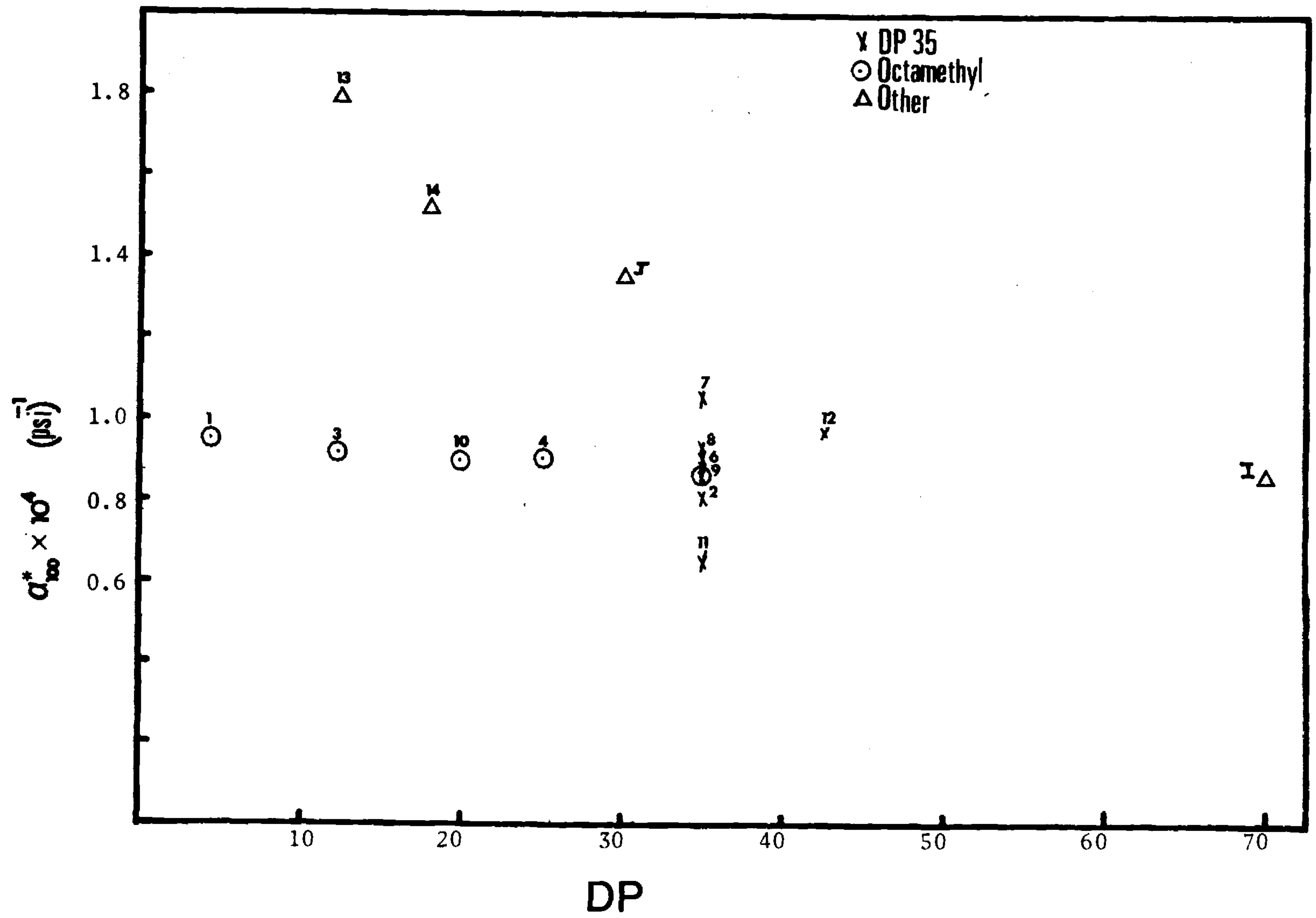



Figure 9 Pressure Viscosity Characteristics $\alpha^*$ as a Function of DP at 100F.

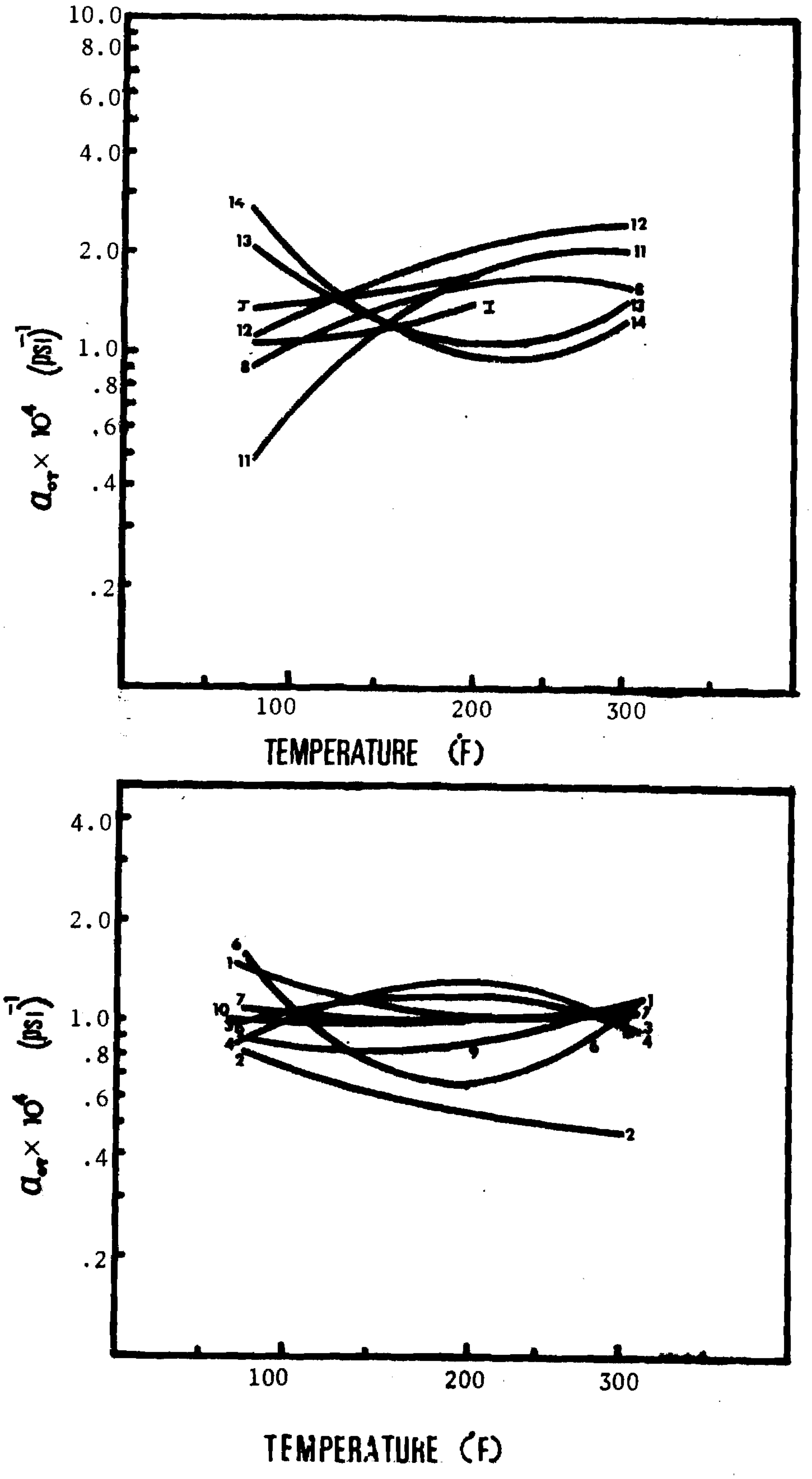



Figure 10A Temperature Dependence of Pressure-Viscosity Coefficients: $\alpha_{oT}$

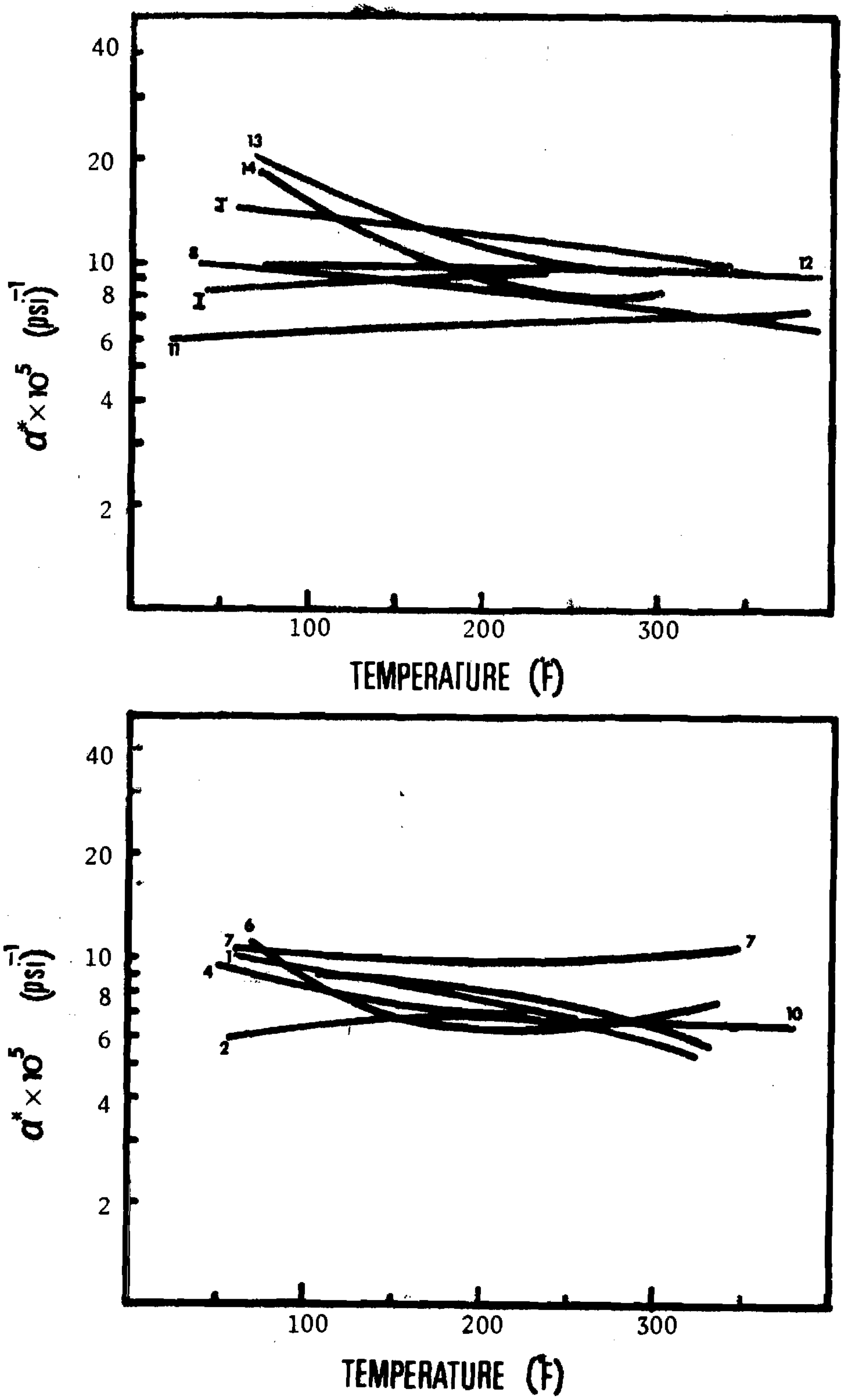
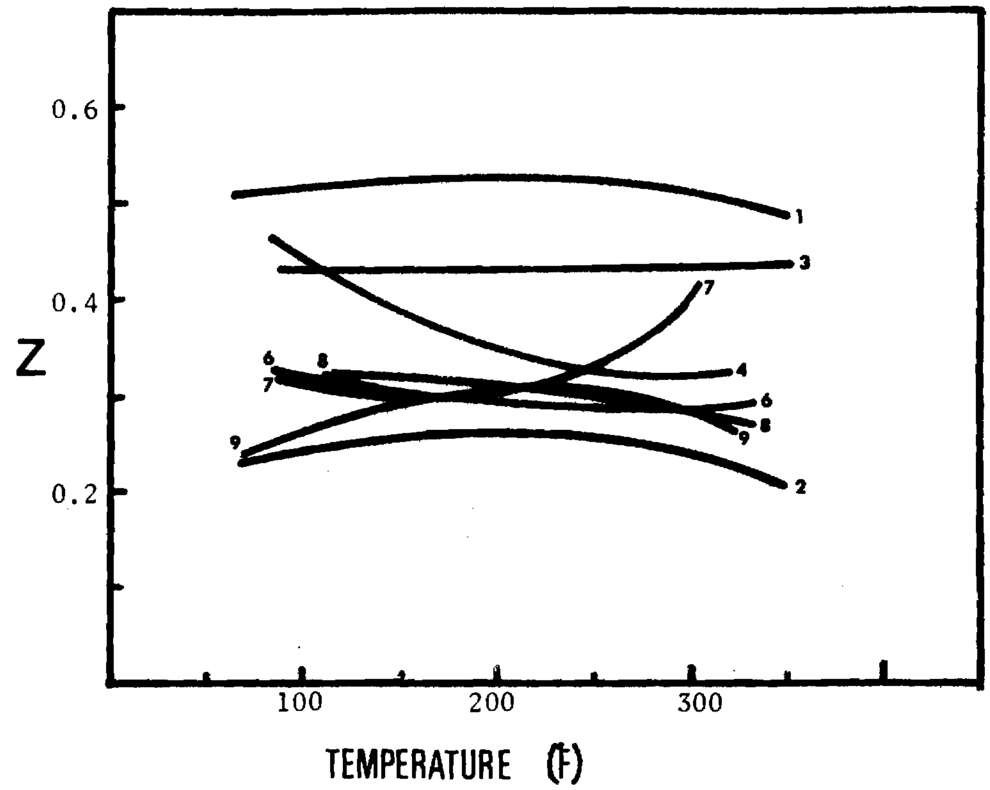



Figure 10B Temperature Dependence of Pressure-Viscosity Coefficients: α*



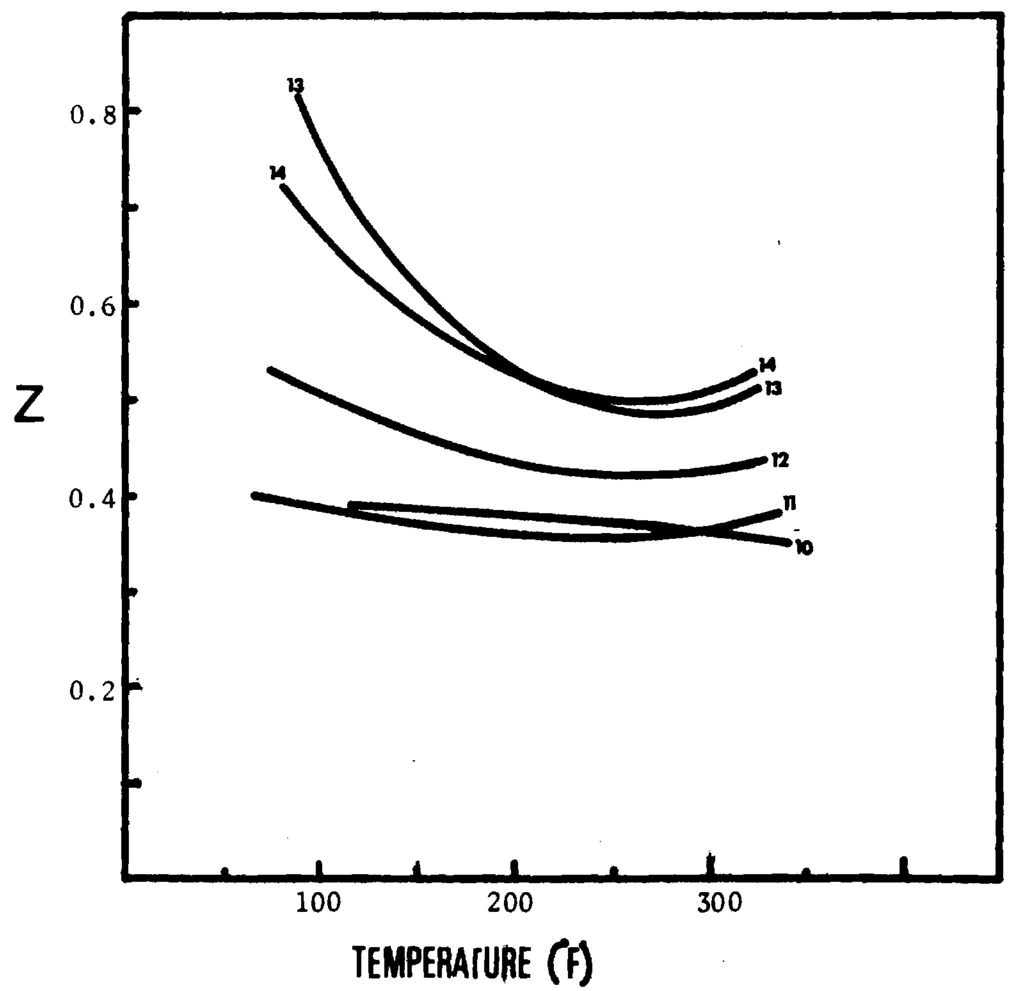




Figure 10C Temperature Dependence of Pressure-Viscosity Coefficients: Z

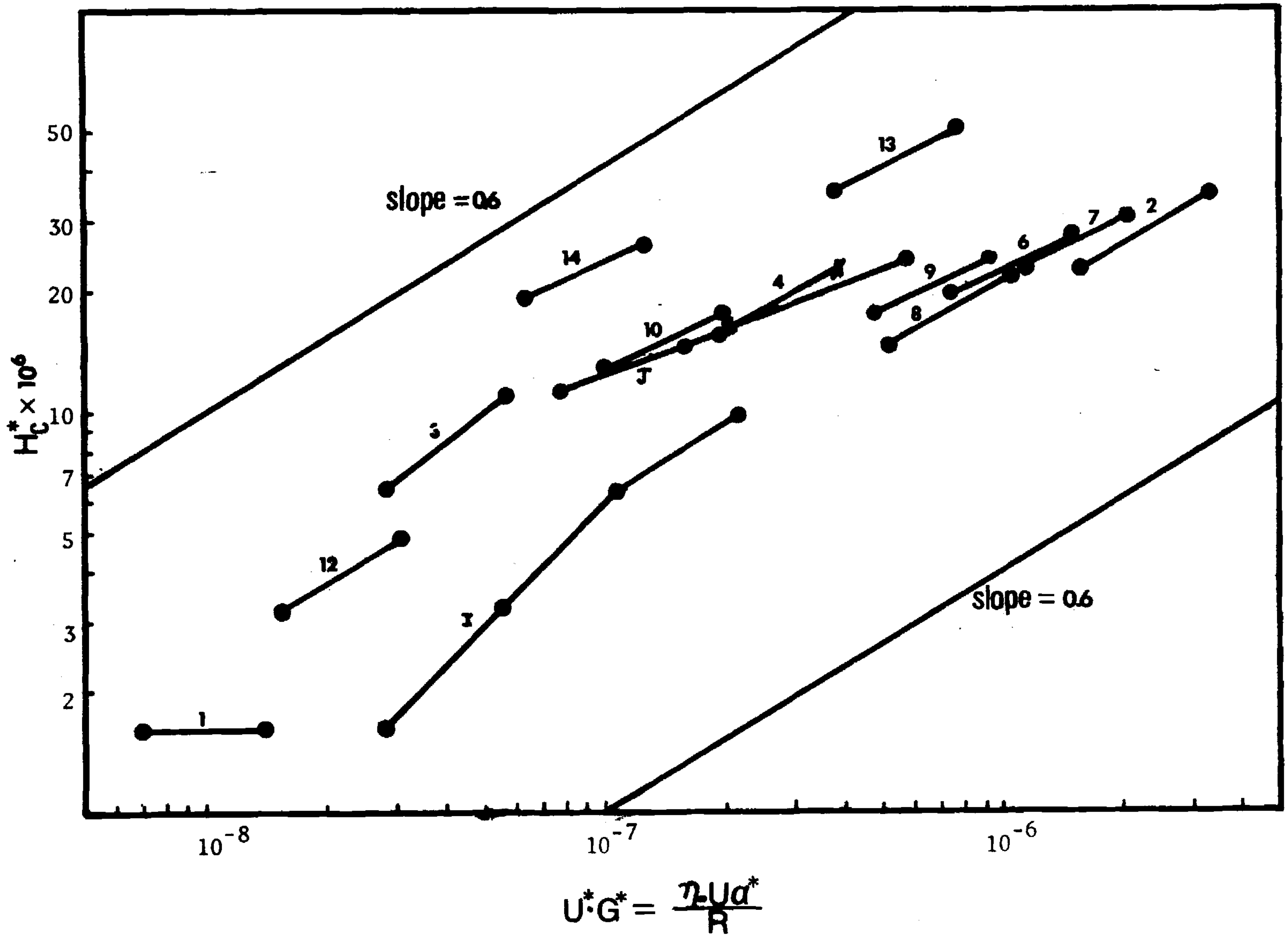



Figure 11 Dimensionless Centerline Film Thickness Parameter as a Function of the Combined Speed-Materials Parameter.

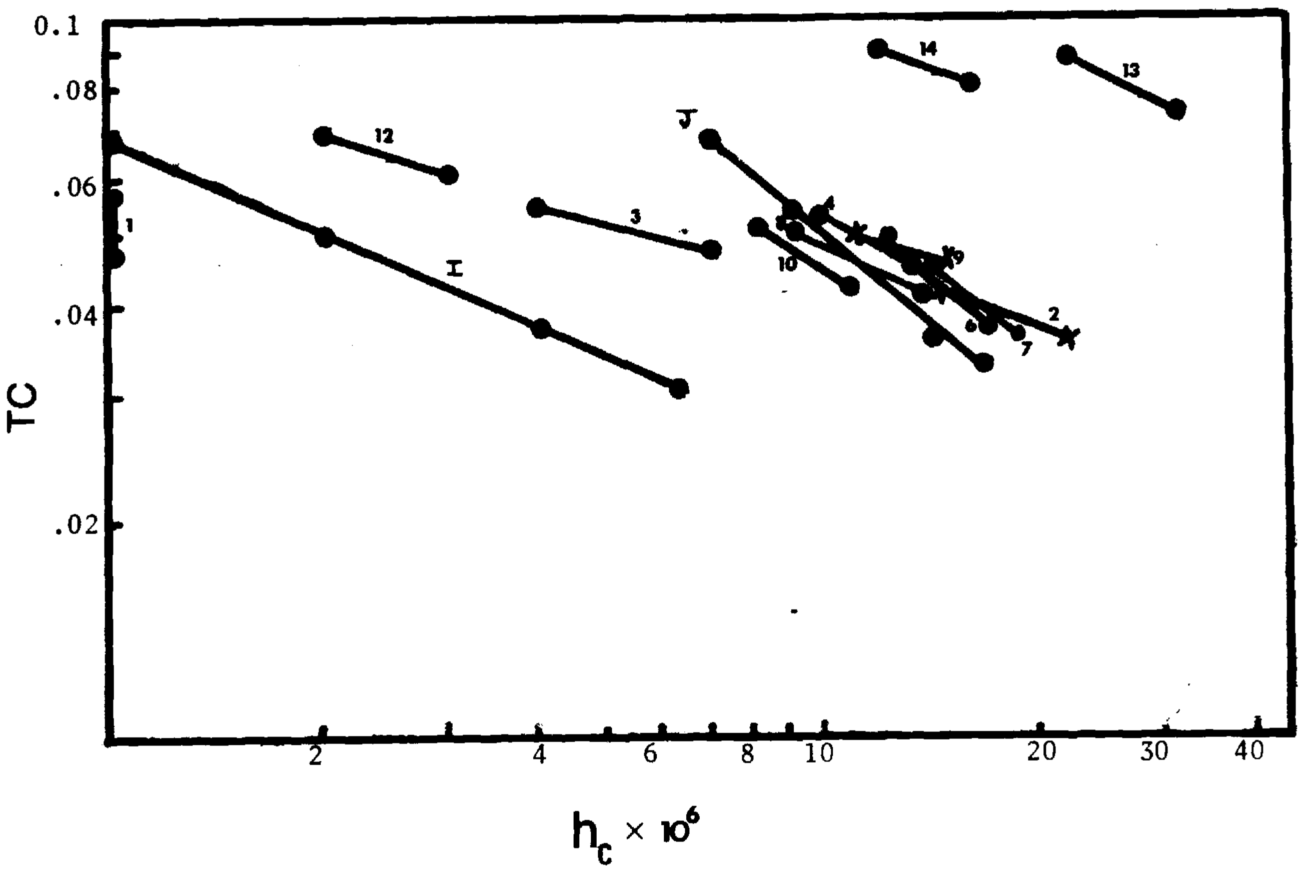



Figure 12 Traction Coefficient as a Function of Centerline Film Thickness

DOW CORNING

Appendix A-1

February 9, 1972

Dr. Ward O. Winer
Associate Professor
School of Mechanical Engineering
Georgia Institute of Technology
Atlanta, Georgia 30313

Dear Ward:

To help clarify the unexpected viscosity data for the dodecylmethyl and tetradecylmethyl siloxanes in the series of alkylmethyl siloxane fluids which Dow Corning sent you, I ran some gas chromatography analysis on these fluids. I found 3% unreacted $C_{14}H_{28}$ present in the $(C_{14}H_{29}CH_3SiO)n$ sample. This quantity of diluent in the fluid would be expected to lower the 25°C viscosity of the fluid to a significant extent (perhaps 500-1000cs). Most other physical properties would be affected less significantly.

Chromatography of the $(C_{10}H_{21}CH_3SiO)n$ and $(C_{12}H_{25}CH_3SiO)n$ samples showed no residual olefins.

It becomes increasingly difficult to distill out low molecular weight species from the polysiloxanes as the alkyl group increases in size. Therefore, the $(C_{16}H_{33}CH_3SiO)n$ sample probably also contains olefin. The sample of $(C_{12}H_{25}CH_3SiO)n$ was prepared by different people than the rest of the series and was almost certainly stripped to a higher temperature than the others. This would result in a higher average molecular weight (or $\overline{DP}$) and a higher viscosity for this fluid.

I hope these observations and comments are helpful to you.

Very truly yours,

Eugene D. Groenhof

/maw

October 7, 1970

Dr. Ward O. Winer
School of Mechanical Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

Dear Ward:

You will be receiving fourteen (14) fluid samples shortly. They are being shipped this week from Midland.

| | | RMeSiO (R=) | Viscosity (cs) (77°F) |
|---|---|---|---|
| XF-4-3526 | E-1318-88-1 | $C_8H_{17}$ | 25 |
| XF-4-3556 | E-1318-88-2 | $C_{12}H_{25}$ | 8856 |
| XF-4-3555 | E-1318-88-3 | $C_8H_{17}$ | 105 |
| XF-4-3554 | E-1318-88-4 | $C_8H_{17}$ | 770 |
| XF-4-3553 | E-1318-88-5 | $C_{16}H_{33}$ | Solid |
| XF-4-3552 | E-1318-88-6 | $C_{10}H_{21}$ | 2390 |
| XF-4-3551 | E-1318-88-7 | $C_{14}H_{29}$ | 3390 - see Groenhoff letter Feb 9, 72 |
| XF-4-3550 | E-1318-88-8 | $C_6H_{13}$ | — |
| XF-4-3549 | E-1318-88-9 | $C_8H_{17}$ | 1864 |
| XF-4-3548 | E-1318-88-10 | $C_8H_{17}$ | 373 |

DC 1107 lot no. AA1534
DC 200/20 cs. 50 cs label error.
DC 710 lot no. HH 266
DC 550 lot no. BFO-574

Enclosed is the information that you requested on the LFW-1 test procedures.

With best regards,

George J. Quaal
Lubricants Research

GJQ/jdl

June 24, 1970

Dr. Ward Winer
Department of Mechanical Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

Dear Ward,

In separate shipment, I am sending you 1-quart samples of two types of siloxanes:

(1) Adducts of the form $Me_3SiO(\overset{Me}{\underset{R}{Si}}O)_{35}SiMe_3$,

| | |
|---|---|
| where R = $C_0H_1$ | 25 cs at 77°F |
| ✓ $C_1H_3$ | 50 |
| ✓ $C_6H_{13}$ | 1,895 |
| ✓ $C_8H_{17}$ | 1,864 |
| ✓ $C_{10}H_{21}$ | 2,390 |
| ✓ $C_{12}H_{25}$ | 8,850 |
| ✓ $C_{14}H_{29}$ | 3,390 |
| ✓ $C_{16}H_{33}$ | Solid |

The $C_2H_5$ and $C_4H_9$ adducts were impossible for us to prepare; the $C_6H_{13}$ adduct was not in line with the other fluids because of hexene instability and polymerization. The $C_{12}H_{25}$ adduct is a big question mark, too, since that was prepared much later than the others. I would not count on its integrity.

(2) Adducts of the form $Me_3SiO(\overset{Me}{\underset{C_8H_{17}}{Si}}O)_xSiMe_3$, where x is varied to achieve a range of viscosities: 25.2, 105, 373, and 770 cs at 77°F.

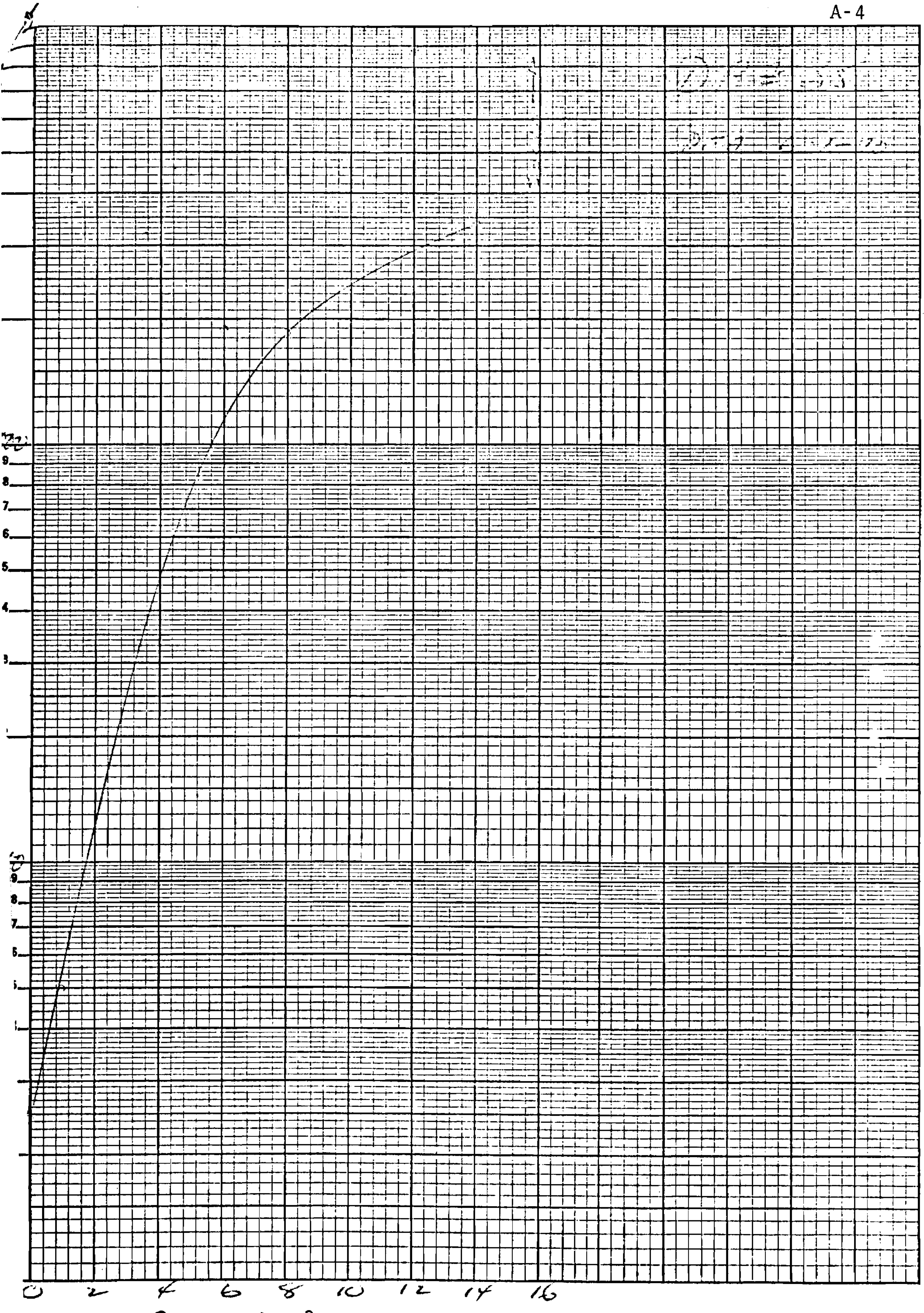
I hope these fluids are sufficient for your work, and apologize for the many delays in getting them to you.

Thanks again for your interest, and I look forward to your results.

Douglas E. Aldrich

DEA/py

Enclosure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# Some Measurements of High Pressure Lubricant Rheology

*The advancement of the fields of elastohydrodynamic lubrication and high pressure metal forming in the past few years has focused attention on the need for reliable data of the variation of viscosity with pressure, temperature, and shear stress in well-defined fluids. This paper describes an investigation in which these effects were observed. The equipment used was a high pressure capillary-type viscometer which made possible the continuous variation of shear stress over a wide range at pressures up to 80,000 psi. Well-defined paraffinic and naphthenic base oils and several polymer blends of these oils were investigated as well as a polybutene, a diester, and two silicone fluids.*

## Introduction

There is a need for knowledge of the rheological behavior of liquid lubricants under the combined effects of high pressure and high shear rate. Such information will not only contribute to our understanding of the physics of lubrication mechanisms but also act as a guide in the formulation of future lubricants. Many mechanisms of lubrication formerly thought to be in the category of "boundary" lubrication [1, 2][1] (i.e., dependent on the chemical interaction of the lubricant and the surface being lubricated) are, in light of recent analytical and experimental investigations, now thought to be of the elastohydrodynamic type [3, 4, 5, 6] (i.e., dependent on the mechanical interaction of the physical properties of the lubricant and those of the solid being lubricated). A major problem associated with the work in the area of elastohydrodynamic lubrication is the lack of data on the behavior of the liquids when they are subjected to the combined effects of high pressure and high shear rate.

The work described in this paper is an attempt to determine the combined effects of pressure, shear rate, and temperature on lubricating fluids. A capillary viscometer has been employed and a number of well-defined fluids investigated. Only time-independent properties have been determined. It is recognized that time-dependent properties may be significant in high speed highly loaded devices and therefore some lubricants may behave differently in some applications than they did in this investigation.

These data should contribute to the understanding of the relative importance of the two modes of lubrication in highly loaded contacts such as gears, cam followers, and rolling element bearings. A better understanding of the relative importance of boundary and elastohydrodynamic lubrication mechanisms is clearly of value in the formulation and use of lubricants because, on the one hand, the chemical properties of the lubricant are more important and therefore must be studied and enhanced and, on the other hand, the physical properties are more important. A clear understanding of the two modes of lubrication is also of value in the mechanical design of lubricated mechanisms.

The effect of pressure upon the viscosity of liquids has received much attention. The earliest investigation reported was dated in 1892 [7]. The most extensive single investigation was that reported by the ASME in 1953 [8]. Hersey [9] summarized the work reported in the literature prior to 1952 and more recently [10] has summarized the work conducted between 1952 and 1965. The upper limit of pressure in past investigations has ranged from as low as 2000 psi to as high as 425,000 psi by Bridgman [11]. With few exceptions the research into the effect of high pressure on viscosity has been conducted with a falling-body-type viscometer. The disadvantage of this type of instrument is that it subjects the fluids to very low shear stresses (approximately 250 dyn/cm$^2$; cf., [8]) and therefore gives no indication of the effect of shear stress upon viscosity.

One exception to the trend of low shear stresses has been the work of Philippoff [12] in which he employed a vibrating crystal viscometer in a pressure cell. This technique made possible the measurement of viscosity at discrete shear rates which are a function of the crystal geometry used. By employing a reduced variable approach the data could then be made applicable to a wide range of shear rates. Philippoff's maximum pressure was 15,000 psi which was limited in part by the fact that current instrumentation for vibrating crystal viscometers is limited to the measurement of viscosities below about 5 to 10 poise.

Two additional previous investigations deserve special mention because of their relation to this work. These are the works of Hersey and Snyder [13] in 1932 and that of Norton, et al. [14] in 1941. Both of these investigations also employed a capillary viscometer to determine the pressure-viscosity variations.

In 1932, Hersey and Snyder [13] studied the flow of liquids in capillaries which exited to the atmosphere with inlet pressures up to 40,000 psi. This was high enough to cause an appreciable change in the viscosity of the test fluid. Thus the viscosity could not be treated as uniform throughout the capillary. The results were put in the form of Poiseuille's law with a correction factor obtained by integration of the empirical viscosity-pressure relation. If the form of the viscosity-pressure function was unknown, it was determined by differentiation of the flow rate versus inlet pressure curve. This method was less sensitive and less accurate, but much more rapid than the rolling ball and falling weight methods previously used.

Norton [14] was the first to eliminate the problem of viscosity variation along the capillary at elevated pressures. His equipment had a maximum pressure level of 50,000 psi and eliminated the viscosity variation by using two capillaries in series. The first was a short test capillary with a Bourdon pressure gage at each end. The second capillary was a long flow resistance tube with atmospheric pressure at the exit. This technique enabled Norton to subject the test fluid to a high pressure level and still maintain a small pressure drop across the capillary. The results are presented as preliminary and the problems associated with the technique were not solved before his untimely death. The lack of repeatable accuracy of the Bourdon gages was the major problem in accurately measuring the pressure drop across the capillary.

## Experimental Equipment

The experimental apparatus (Fig. 1) used was a two-way high

[1] Numbers in brackets designate References at end of paper.

Contributed by the Lubrication Division of The American Society of Mechanical Engineers and presented at the ASME-ASLE-ASTM Symposium on Lubrication and Lubricant Rheology, Ann Arbor, Mich., March 18–20, 1968. Manuscript received at ASME Headquarters, December 18, 1967. Paper No. 68—LRh-1.

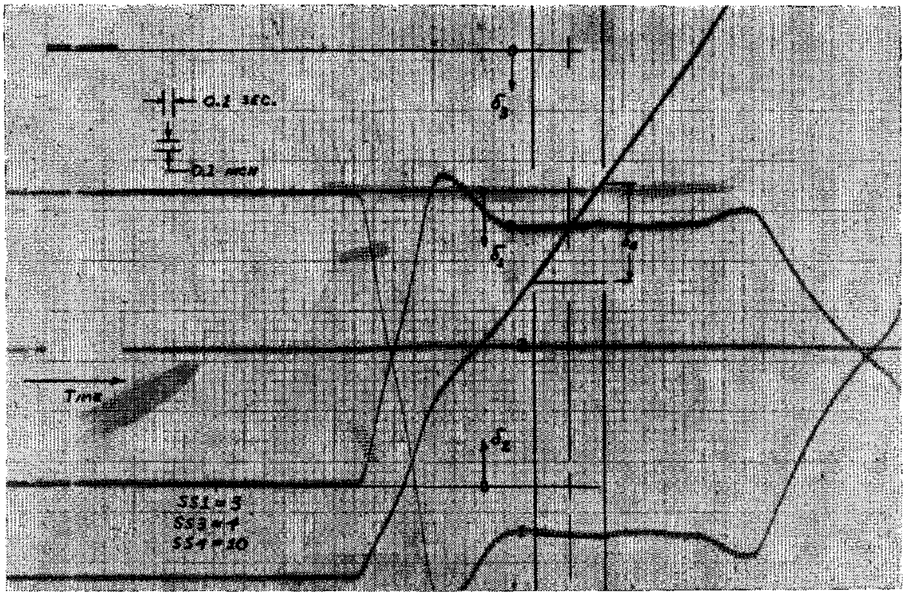


Fig. 5 Typical transducer output

In addition to the capillary geometry, the data required consisted of temperature, volume flow rate, pressure level, and pressure drop across the capillary. The temperature of the bath, in which the capillary section and much of the high pressure tubing was immersed, was determined with a calibrated mercury-in-glass thermometer. The volume flow rate was determined by measuring the displacement between the fixed high pressure ram and the translating piston (see Fig. 2). The measurement was made with an inductance displacement transducer whose signal was recorded continuously as a function of time. Precautions were taken to keep the fluid which was in the tubes above the constant temperature bath from flowing into the capillary section.

The pressures were measured directly in the high pressure fluid with commercial strain gage pressure transducers. This method eliminated the influence of seal friction on these measurements. The pressure level of the test fluid was measured with pressure transducer G1 (see Fig. 2). The pressure across the capillary was measured with a pair of pressure transducers, G2 and G3, which were placed at opposite ends of the capillary. The electrical outputs of G2 and G3 were nulled, through electrical balancing, at any pressure level. Then, by amplifying the signal from these transducers through high gain d-c amplifiers, small fluctuations of pressure about the pressure level were detected with considerable accuracy.

The signals from the three pressure transducers and the displacement transducer were supplied to galvanometers in an ultraviolet oscillographic recorder and were recorded continuously as a function of time. A time-base signal was also recorded. Thus it was possible to assure that steady-state conditions existed when the data were obtained. A typical recording trace is shown in Fig. 5.

The two measurements which limited the range of experimental data were the shear stress and the flow rate. The minimum shear stress obtainable was limited by the smallest measurable pressure differential and the longest capillary. The maximum shear stress obtainable was limited by the shortest capillary and the pressure difference at which the viscosity of the test fluid in the capillary could not be considered uniform. These limits are represented by the two vertical lines in Fig. 7. The two lines with the slope of unity (Fig. 7) are lines of constant shear rate and are determined by maximum and minimum flow rate.

Another limitation is reached at that combination of pressure and temperature at which the fluid begins to form a gel structure. When this phenomenon occurs the fluid behavior becomes quite complex and not readily analyzed. Other factors which might have further restricted the range of useful data, or required corrections, were transient flow behavior of the test fluid and change in the capillary diameter at elevated temperature and/or pressure. These factors were investigated analytically and their possible effect on the viscosity data was shown to be negligible. The effect of viscous heating which can also be important is discussed later.

The atmospheric pressure data were obtained in the standard manner employing a calibrated glass capillary to determine the kinematic viscosity at low shear rate. The effect of shear rate at atmospheric pressure was obtained in the equipment used to calibrate the capillary diameters. The capillaries employed are listed in Table 1.

## Calibration

The core of the displacement transducer was attached to a micrometer head mounted on the transversing piston. Thus the calibration was obtained by recording micrometer displacement versus recorder galvanometer displacement.

The manufacturer of the three strain gage pressure transducers supplied calibration data for each transducer up to 100,000 psi. Because of the extreme amplification of the signal from the two gages used for the differential pressure measurement further calibration was made. This consisted of a calibration on a deadweight gage to 12,000 psi and of the measurement of viscosity in the system of a well-defined fluid for which viscosity-pressure data had been reported. The deadweight gage was a Ruska Model 2400 capable of accurately determining pressures to within 10 parts per million at any pressure level below 12,140 psi. The deadweight gage confirmed the manufacturer's calibration data up to 12,000 psi and demonstrated the feasibility of the method for determining the pressure drop across the capillary. It was necessary to rely on the supplied calibration data above 12,000 psi.

The maximum sensitivity of the instrumentation is such that a galvanometer deflection of 0.11 in. was produced when the pressure in the deadweight gage was increased from 10,000 psi to 10,001 psi. Thus the maximum sensitivity was 9.1 psi/in. However, in order to increase the maximum measurable pressure difference the data were collected with lower amplifier gain settings (12–250 psi/in.).

To verify the accuracy of the system a bis-2-ethyl hexyl sebacate fluid was used. The viscosity-pressure data obtained were

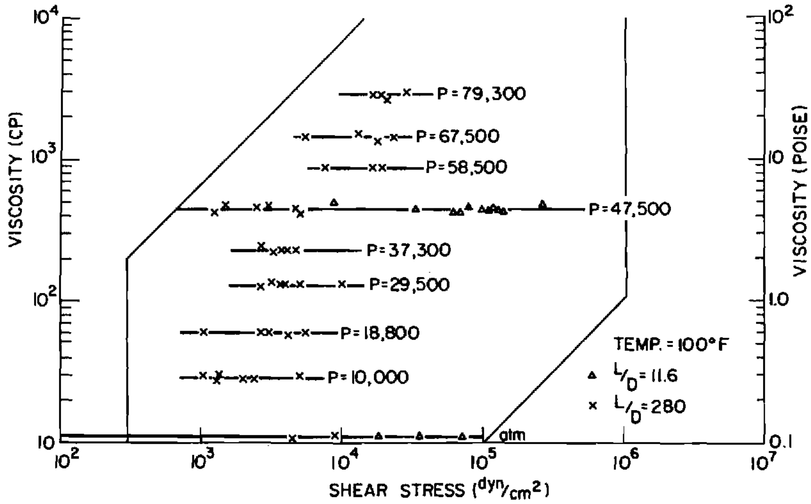


**Fig. 7 Flow curve for fluid A (diester)**

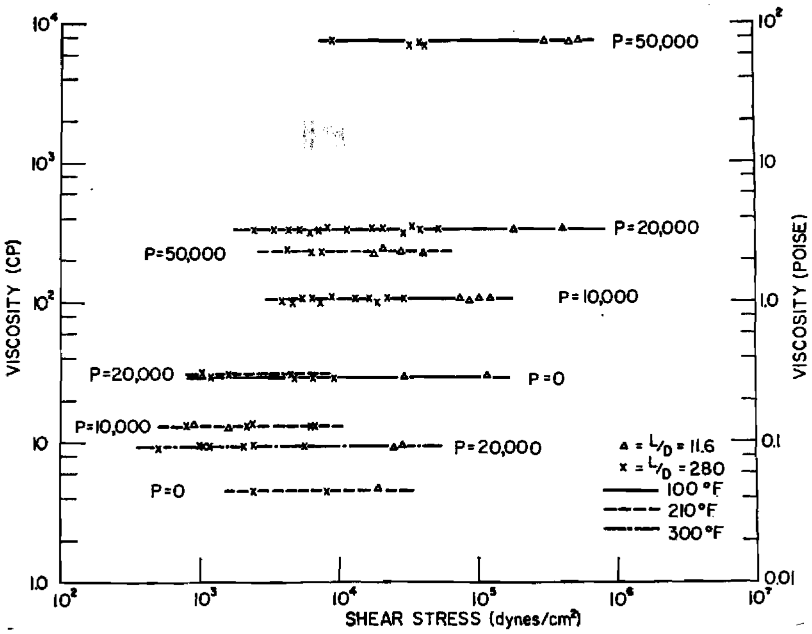


**Fig. 8 Flow curve for fluid B**

fluid. Hence the data itself is an indication that viscous heating is negligible over the range of shear-rate shear-stress product up to $10^3$ w/cm$^3$.

The capillary geometry and the short-time duration required to obtain data appear to be the reasons that viscous heating is not a problem below $10^3$ w/cm$^3$. This high rate of viscous dissipation only occurs for a few seconds at the capillary wall. Thus the volume of fluid actually subjected to this high rate of energy input is extremely small. The high thermal capacity of the capillary wall enables it to act as an effective heat sink during this short-time period; thus the assumption of an isothermal wall seems to be justified.

The absence of thixotropic or rheopectic behavior is indicated by the agreement between data on the same fluid taken in capillaries of differing length-to-diameter ratios as long as there was no gelation in the fluid. Gelation results from the solidification of some constituents in the fluid at certain combinations of pressure and temperature. It was readily detected in the instrument because it caused the pressure differential signal to be delayed with respect to the displacement signal and resulted in an inability to repeat data successively under supposedly identical conditions. The temperature-pressure combinations at which gelation was observed to begin agreed well with those at which "solidification" was reported in the ASME Viscosity-Pressure Report [8] for similar fluids. Although it may be possible, no attempt was made to systematically determine the rheological behavior of the fluids when a gel structure existed.

The major source of error which limits the accuracy of the data was the measurement of the galvanometer signals on the recording. The maximum error in the distance measurement between the reference lines and the galvanometer traces was estimated to be less than 0.02 in. Thus the percentage of error was reduced by obtaining large galvanometer deflections. An analysis of this effect shows that the smallest possible random error of $\pm 1.0$ percent would be reached if the three galvanometer signals each produced their maximum displacement of 5 in. For the experimental data, however, the displacements were less. The random error of a single data point for most of the experimental data was between $\pm 2.0$ percent and approximately $\pm 6.0$ percent. It must be emphasized that this is the maximum possible random error for any one data point. The probable error for each point is less because the errors of the three signals may tend to cancel each other.

The accuracy of the pressure level measurement also effects

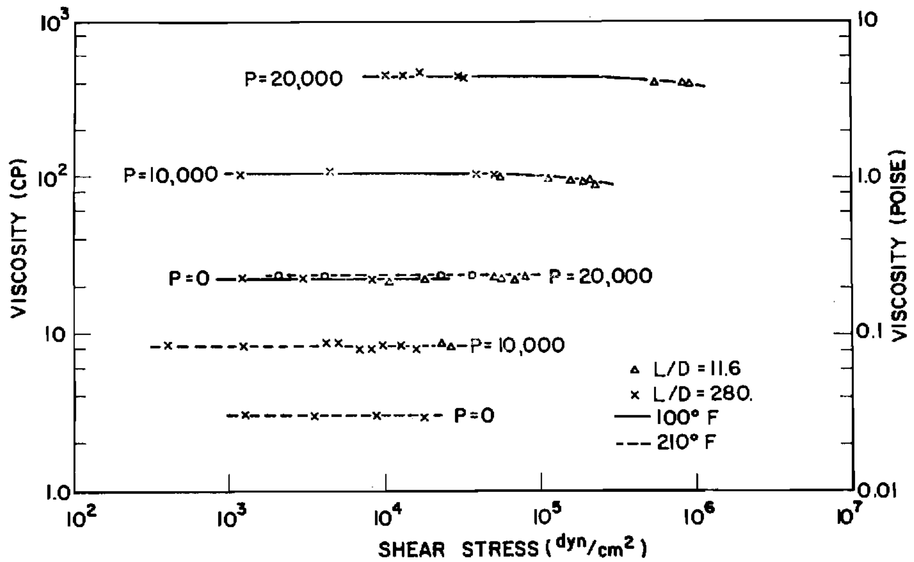


**Fig. 16 Flow curve for fluid F**

| | | |
|---|---|---|
| Viscosity index (ASTM D-2270) | 102 | −13 |
| Flash point (deg F) | 410 | 315 |
| Fire point (deg F) | 470 | 365 |
| Pour point (deg F) | 5 | −45 |
| Refractive index | 1.4754 | 1.5085 |
| Density at 68 deg F (gm/cc) | 0.8596 | 0.9157 |
| Molecular weight[2] | 401 | 305 |
| Percentage of carbon atoms in aromatic rings[3] | 4.0 | 21.5 |
| Percentage of carbon atoms in naphthenic rings[3] | 28.0 | 36.0 |
| Percentage of carbon atoms in paraffinic rings[3] | 68.0 | 42.5 |
| Percentage of carbon atoms in aromatic rings[4] | 4.0 | 20.3 |
| Percentage of carbon atoms in naphthenic rings[4] | 27.4 | 34.5 |
| Percentage of carbon atoms in paraffinic rings[4] | 68.8 | 45.2 |
| Average number of aromatic rings per molecule[4] | 0.20 | 0.77 |
| Average number of naphthenic rings per molecule[4] | 1.59 | 1.74 |
| Average number of total rings per molecule[4] | 1.79 | 2.51 |

Symbol: None; used as additive in C, D, G.
Type: Polyalkylmethacrylate
Source: Rohm and Haas Company

The polymer had a viscosity average molecular weight of 560,000 and was in solution with a paraffinic hydrocarbon very similar to fluid B in this investigation. The solution contained 36.1 percent polymer and had a viscosity of 796 cs at 210 deg F. The percent additive reported in Table 3 (i.e., 4 or 8 percent) was the percent polymer in the final solution.

[2] Calculated from viscosity data using the method of Hirschler, A. E., *Journal of the Institute of Petroleum*, Vol. 32, 1946, pp. 133–161.

[3] Obtained using the viscosity-gravity constant and the refractivity intercept using the method of Kurtz, S. S., Jr., King, R. W., Stout, W. J., and Gilbert, D. J., from a paper, "Relationship Between Carbon-Type Composition Viscosity-Gravity Constant and Refractivity Intercept," presented before the Petroleum Division, ACS, Sept. 1955.

[4] Calculated using the n-d-M method of structural group analysis of mineral oil fractions of Van Nes and Van Westen, *Aspects of the Constitution of Mineral Oils*, Elsevier Publishing Co., Inc., 1951.

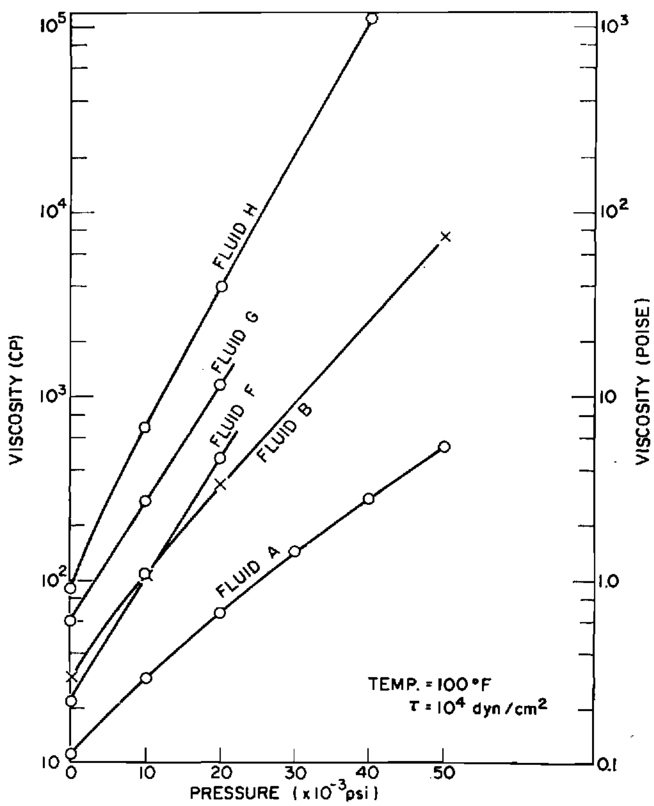


**Fig. 17 Viscosity-pressure relation for fluids A, B, F, G, H**

Symbol: None; used as additive in E
Type: Polytertiarybutylstyrene
Source: Dow Chemical Company

The polymer had a weight average molecular weight of 375,000 as determined by an ultracentrifuge method. The polymer was supplied in solution with a paraffinic hydrocarbon similar to fluid B. The solution contained 25 percent polymer. Fluid E contained 4 percent polytertiarybutylstyrene polymer.

Symbol: H
Type: Polybutene
Source: American Oil Company

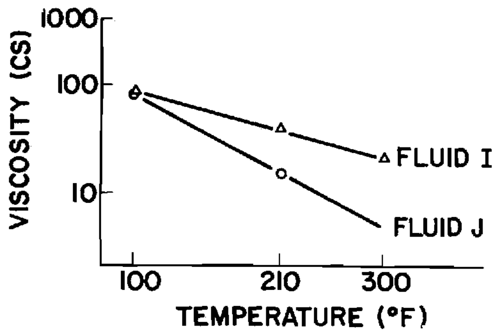


Fig. 20 Viscosity-temperature relation for silicone fluids

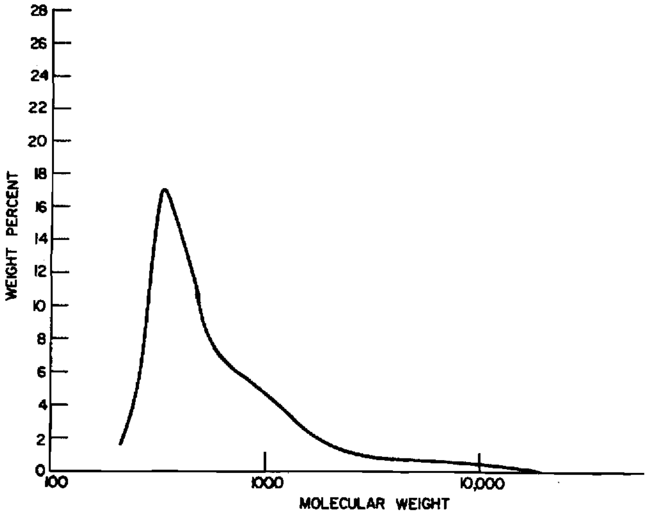


Fig. 21 Molecular weight distribution for fluid H


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# DISCUSSION

## W. Webb[5]

The authors are to be congratulated on solving the difficult problem of obtaining a high shear stress without the presence of such a large pressure differential as to cause the viscosity at the outlet end of the capillary to be so much smaller than that at the input end. Thus the specification of the viscosity as a function of the pressure is not hazy, as in previous high-pressure capillary viscometers capable of high shear stress.

It would be helpful to the reader if when the authors publish a complete paper they would describe: (*a*) The method of filling the viscometer to obtain a gas-free sample; (*b*) whether the fluids in cavities III and IV, Fig. 2, were the fluids under investigation; if not, how was contamination avoided by the small, but probably not zero, leak between R1 and 111 and R2 and IV; (*c*) what physical quantity was changed in the "pressure transducers" to measure the pressure? Item (*c*) is not clear since the strain gages were "in the fluid." Also how was the fluid in the tubes not in the constant temperature bath prevented from entering the measuring capillary since the fluid was driven through the capillary by the fluid from R1 and R2?

The fluids studied were chosen so that they could be well defined. Perhaps, it would be interesting and worthwhile to study, in addition to the diester used, some pure high molecular weight hydrocarbons unless the results obtained with the two oils would enable one to conclude that all such fluids would remain Newtonian under high shear stress.

The low values of the viscosity-pressure coefficient at high pressures should not lead one to overlook the tremendous rate at which the viscosity is rising at pressures above 20,000 psi. As Fig. 17 shows the log viscosity versus pressure, for all the fluids except the diester, rises at least as fast as a straight line. Furthermore as the extensive data of the ASME, author's reference [8], have shown, the curve, log viscosity versus pressure, always rises faster than linear when the pressure is increased to sufficiently higher values for *all* liquids, and at all temperatures so long as the liquid phase exists. This general behavior was also observed by P. W. Bridgman.

It might be interesting to compare the viscosity-pressure coefficients of some pure hydrocarbons with those listed in Table 4. The data for the pure hydrocarbons are taken from Lowitz, Spencer, Schiessler, and Webb, *Journal of Chemical Physics*, Vol. 30, 1959, p. 73.

It would appear therefore that the relative rate of change of viscosity with pressure is the same order of magnitude whether one is dealing with lubricating oils or pure hydrocarbons, and is almost independent of pressure. The fact that log $\mu$ versus pressure approximates a straight line leads one to expect this of course.

## Authors' Closure

Space limitations prevent a complete discussion of the equip-

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# Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts With Transient Loading: 1—Film Thickness

*This paper describes an experimental investigation of the elastohydrodynamic problem. The investigation was limited to a study of nominal point contacts in pure sliding motion. The profile of the lubricant film separating the bearing surfaces was determined during a transient of the normal load. During this transient the Hertzian contact stresses were increased from zero to a maximum of 150,000 lbf/in² in approximately 45 milli-secs. The sliding velocities used in this study were varied from 13.7 to 92.1 ips. The resulting mean shear rate, however, was typically 10⁷ reciprocal seconds. Both pure and polymer-blended naphthenic and paraffinic oils, in addition to several synthetic fluids, were studied. On the basis of the film thickness profiles obtained for the polymer-blended oils, it was concluded that the ambient value of viscosity often used in theoretical considerations does not characterize the behavior of the system. It was also found that the rapid application of the normal load had a negligible effect on the film thickness profile. During this investigation the contact traction was also measured. The results of those measurements are reported in the companion paper, "Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts With Transient Loading: II—Traction."*

## Introduction

THIS paper discusses research recently conducted in the elastohydrodynamic lubrication of point contacts in pure sliding. Unlike previous studies [1, 2, 3][1] concerned with film thickness measurements in sliding point contacts, the measurements in this research were obtained throughout a step loading transient. In addition, measurements of the tractive force were simultaneously obtained [4, 5].

The interest in both film thickness and traction data for EHD point contacts is due to the difficulty encountered in effectively lubricating mechanical elements such as ball bearings, spiral gears, certain cam followers, and in the selection of operating fluids for traction power transmissions.

The center line film thickness $h_c$ has received the most attention in previous studies. This variable is particularly useful in correlating experimental data. It is also the value predicted by available analytical studies From the stand point of wear

[1] Numbers in brackets designate References at end of paper.

Contributed by the Lubrication Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and presented at the ASME-ASLE Lubrication Conference, Cincinnati, Ohio, October 12–15, 1970. Manuscript received at ASME Headquarters, July 16, 1970. Paper No. 70-Lub-21.

## Nomenclature

$a, b, c, d, e$ = exponents in film thickness formulas
$E'$ = reduced elastic modulus
$f$ = exponent in film thickness formula
$G^*$ = dimensionless materials parameter = $\alpha . E'$
$h$ = EHD film thickness
$h_c$ = film thickness at contact center
$h_m$ = minimum EHD film thickness
$H_c^*$ = centerline film thickness parameter = $h_c/R$
$H_m^*$ = minimum film thickness parameter = $h_m/R$
$I_A$ = intensity of ray $A$ in the interferometer
$I_B$ = intensity of ray $B$ in the interferometer
$k$ = refractive index
$K$ = a constant
$n$ = interference fringe order
$P$ = pressure
$R$ = radius of the sphere
$S$ = apparent EHD viscosity loss
$S_v$ = apparent viscometer viscosity loss

(*Continued on next page*)

...minimum film thickness $h_m$ is most ...erefore, has also been determined.

## ...perimental Variables

During this investigation an attempt was made to study the behavior of an EHD contact under conditions more realistic than those previously employed. Film thickness and traction data were obtained during and after a step loading transient. In addition, the loading rate, the sliding velocity, and the lubricant rheology were varied.

Since EHD film thicknesses have been shown to be only slightly ...pendent on the maximum normal load $W_m$ [1, 6, 7], all but a ... experiments used a steady-state load of 15 lbf, which cor...onds to a maximum Hertzian contact stress of approximately ...00 psi. During the loading transient, the instantaneous W reached 95 percent of $W_m$ in 0.040–0.050 sec. This is ...test loading rate available with the existing experimental ...ent.

...g velocities of 13.7, 27.4, 54.9, and 92.1 ips were used with ...icant. The minimum value is the velocity at which the ...cosity fluid can maintain a continuous protective film. ...um value is the velocity at which it became difficult to ...fficient lubricant in the contact inlet to sustain a ...lm for the most viscous lubricant.

...ants selected for examination were chosen on the ...ding a range of values for the ambient viscosity $\mu_0$ ...iscosity exponent $\alpha$, and a variation in lubricant ...group of fluids having this diversity in property ... examined by Novak and Winer [8, 9, 10]. ...ons provide viscosity data for selected lubricants ...ressure, temperature, and shear rate. Viscosi... at pressures up to 80,000 psi and at shear rates ...the higher pressures examined. It was esti...cal EHD contact of this study had a mean ...re of 100,000 psi and a shear rate in the ...$sec^{-1}$ to $10^7$ $sec^{-1}$. Novak and Winer's ...ditions more nearly representative of those ...han any other available. The thirteen ...study are listed in Table 1. Detailed ...ids and additives are given in Appendix

**Table 1 Experimental fluids** C-2

| | |
|---|---|
| **Naphthenics** | |
| N1 | Naphthenic base oil (R-620-15) |
| N2 | N1 + 4% polyalkylmethacrylate (PL-4521) |
| N3 | N1 + 4% polyalkylmethacrylate (PL-4523) |
| **Paraffinics** | |
| P1 | Paraffinic base oil (R-620-12) |
| P2 | P1 + 4% polyalkylmethacrylate (PL-4521) |
| P3 | P1 + 8% polyalkylmethacrylate (PL-4521) |
| P4 | P1 + 18% polybutene (LP-5196) |
| P5 | P1 + 4.4% polybutene (LP-5346) |
| P6 | P1 + 4% polyalkylmethacrylate (PL-4523) |
| **Synthetics** | |
| S1 | Diester-Plexol 201 bis-2-ethyl hexyl sebacate (PL-5159) |
| S2 | Polybutene (LP-5193) |
| S3 | Dimethylsiloxane (DC-200) |
| S4 | Trifluoropropylmethylsiloxane (XF1-0294) |

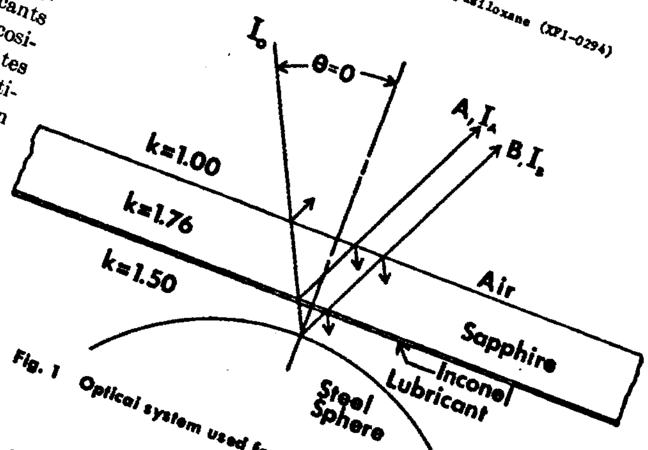


Fig. 1 Optical system used for film thickness measurement

## ...d Equipment

...nique was used to determine the ... in the EHD contact. The inter... by Cameron and his co-workers ...e basic components of the inter... a 100 Å thick layer of Inconel, ...mium steel ball. The EHD ...ere about an axis parallel to ...ally loaded against it. ...the flat disk primarily be.... The sapphire disk is 1.0 in. dia, 0.125 in thick, and is flat to within an eighth of a wave length. There are two undesirable characteristics of synthetic sapphire, however, which had to be improved before good quality interference patterns could be obtained.

The interference of the two reflected rays A and B in Fig. 1 are almost totally responsible for the observed interference pattern. Because the refractive index of sapphire is close to that of the lubricant, there is insufficient reflection at the sapphire-lubricant interface. In order to make the intensity $I_A$ more

$W_m$ = maximum (steady-state) normal load
$\alpha$ = pressure-viscosity exponent (tangent)
$\bar{\alpha}$ = pressure-viscosity exponent (secant)
$\dot{\gamma}$ = shear rate
$\Delta\phi$ = net phase shift of interfering rays
... = peak intensity of incident light
$\mu$ = lubricant viscosity
$\mu_e$ = effective EHD viscosity
$\mu_0$ = low shear, low pressure viscosity
$\rho$ = lubricant density
$\phi_s$ = side leakage film thickness reduction factor
$\phi_T$ = thermal film thickness reduction factor

...n ... in ... 10 ...ered. ... using ...ensity ...ity and ...lculated ...nsity was ... of Wright ... Winer [17] ...ort [18] for ...d. Once the ... index was ob-

(3)

...is cited by Bridgman ...inic oil at pressures as ...termined from ambient ... Hertzian pressure profile ... high pressure areas of the ... are of primary interest. ... pressure estimate at a level ... percent error in the density ... or in the resulting refractive

...ge patterns were observed and ... metallurgical microscope. The ...oscope was also used to direct the ... contact. Photographs were taken ... transient with a 16 mm Bolex reflex ...egative-type black and white film was ..., thus simplifying processing. Prints ...plication purposes. The camera was ... second during the loading transient.

...e normal load is applied pneumatically by ...e bellows located below the sphere support ...el. The strain gage load cell located below ...s a means of recording $W(t)$. The signal ...as momentarily interrupted once during each ... mounted on the motion picture camera. This ...taneous value of $W$ to be assigned to a given

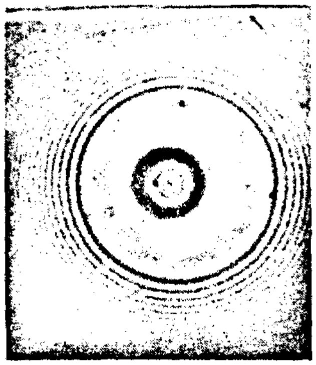

Fig. 9(a) Fringe pattern for fluid S2 for squeeze film experiment

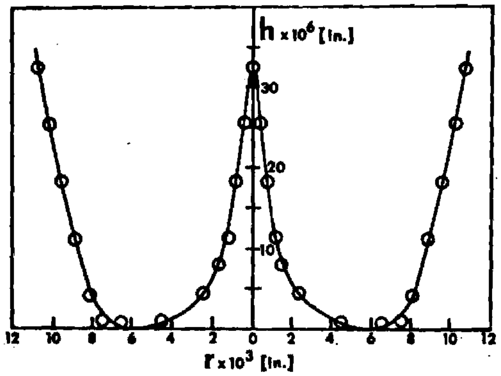


Fig. 9(b) Film thickness profile for fluid S2 for squeeze film experiment

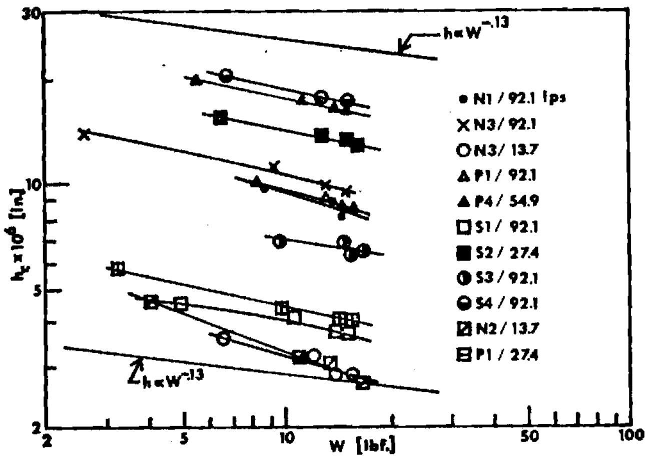


Fig. 10 Variation of center line film thickness with load during a loading transient

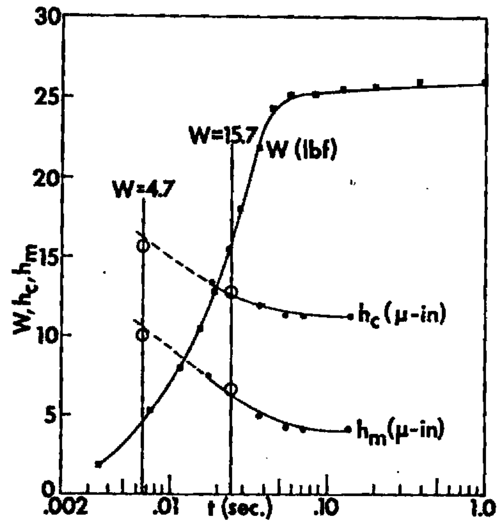


Fig. 11

thicknesses regardless of whether the average molecular weight is 560,000 or 1,650,000 and whether the inlet viscosity is 101 cp or 369 cp. Paraffinic fluids containing a 4 percent concentration of polyalkylmethacrylate with a molecular weight of 560,000 and 1,650,000 and an 8 percent concentration with a molecular weight of 560,000 all appear to have the same effective viscosity on the basis of film thickness correlation. The viscosity of the fluid is apparently being reduced to a level typical of the polymer type and not the concentration or molecular weight. The fluids containing polybutene additives, P4 and P5, do not exhibit the large values of viscosity loss typical of the polyalkylmethacrylates. The range of values of $H_m^*$ is also shown in Fig. 7.

Since the minimum film thickness $H_m^*$ is also of importance, the ratio $H_m^*/H_c^*$ is plotted in Fig. 8 for all available steady state data. The data which does not conform to the general trend shown in Fig. 8 was obtained using fluids S1 and S3. The scatter for $H_c^* < 3 \times 10^{-6}$ is mostly due to the one microin. limit in film thickness resolution. The fact that $H_m^*/H_c^*$ approaches 1.0 as $H_c^*$ is reduced supports the suggestion of Gohar and Cameron [2] that the profile for thin films is nearly Hertzian. If surface wear protection is of primary importance in design, it is obvious from Fig. 8 that the value of $H_c^*$ alone, obtained from theoretical analyses or empirical relations, is inadequate.

**Transient Measurements**

A set of experiments were performed in which the sphere was loaded against the sapphire at the same rate as in the EHD experiments, but with zero sliding velocity. The resulting squeeze film is shown in Fig. 9. It was on the basis of the large amount of surface deformation shown in Fig. 9 that a significant effect on the film thickness was expected during the loading transient due to the rapidly applied load. It can be shown, however, that the effect of the change in load on $h_c$ is the same as would be expected from a quasi-steady experiment in which the same load variation was carried out over a longer period of time. Fig. 10 shows the centerline film thickness plotted as a function of the instantaneous load $W$ during the loading transient. The power law relation

$$h_c \propto W^{-0.13} \tag{19}$$

for constant $U^*$ and $G^*$ used by Dowson and Higginson [6] for line contacts and by Cheng [18, 19] for point contacts is also shown in Fig. 10. The relation in equation (19) is based on an analysis for time-steady loads only. The data points shown in Fig. 10 represent a variety of fluids and sliding velocities. It is apparent that the data is in good agreement with equation (29) for experiments resulting in large values of $h_c$. This is an indication of a negligible effect on film thickness during rapid load application. The deviation from the power law relation evident in thinner films appears to be random when all data is considered. This deviation could be attributed to the one microin. resolution in film thickness measurement.

To further substantiate the claim that the effect of rapid load application on $h_c$ and $h_m$ is small, steady state and transient film thicknesses corresponding to the same instantaneous load were compared for S2, the fluid giving the most deformation in squeeze film studies. Fig. 11 shows the time variation of $W/W_m$, $h_c$, and $h_m$ for $W_m \simeq 26$ lbf with a loading time of approximately 0.050 seconds. The values of $h_c$ and $h_m$ plotted at $t = 0.0066$ sec and $t = 0.024$ sec were obtained from the steady-state data of separate experiments in which $W_m = 4.7$ lbf and $W_m = 15.7$ lbf, respectively. Both steady-state and transient values of $h_c$ and $h_m$ are in excellent agreement at an instantaneous load of 15.6 lbf ($t$ = 0.024 sec). The corresponding values at a load of 4.6 lbf appear to be in agreement with a possible extrapolation of the transient data.

For the lowest sliding velocity used (13.7 in/sec) any given point on the surface of the sphere is in the EHD contact less than $10^{-3}$ sec. This is roughly 1/50 of the load application time. Neglecting the effects of steady load hydrodynamic pressure generation, a given point on the surface of the sphere will experience approximately 1/50 of the pressure rise attributed to the normal approach of the surfaces. This is approximately 3000 psi at the center of the contact. Because of its lower modulus of elasticity, most of the squeeze film deformation should be occurring in the surface of the sphere rather than the sapphire. In pure squeeze film experiments, the same fluid elements and area of the spherical surface experience the entire 100,000 psi mean pressure rise. Because of this basic difference in the two experiments, in retrospect, it does not seem surprising that the effect of a squeeze film in the EHD contact is not significant.

## Conclusions

This investigation encompassed a more realistic set of operating conditions than previous EHD experiments in that a maximum Hertzian stress of 150,000 psi was attained at the completion of a 0.045 sec loading transient during which the film thickness interference patterns, total normal load, and the tractive force were all recorded. Hydrocarbon fluids, polymer containing hydrocarbon solutions, and bulk polymer lubricants were investigated. The minimum as well as centerline film thicknesses were reported. As a result of the transient film thickness measurements, one can conclude that during a rapid loading transient with superimposed sliding the film thickness can be predicted from the steady state behavior. As others have observed, the minimum film thickness occurs in the side lobes rather than either the center or trailing edge of the contact zone.

By investigating these side lobes it was found that the minimum film thickness can be significantly less than the centerline film thickness which has received much attention from previous investigators. In some cases the minimum was as little as 15 percent of the centerline film thickness and did not attain the oft mentioned value of 75 percent until the centerline film thickness reached 30 to 40 $\times 10^{-6}$ in. Obviously the minimum film thickness is of primary concern to machine designers and the result that the minimum can be $^1/_7$ rather than $^3/_4$ of the centerline value should be of concern to them.

Finally, the effects of lubricant rheological behavior on film thickness are important. The lubricants investigated include materials that exhibit non-Newtonian and viscoelastic behavior under some flow conditions. The lack of correlation of the measured film thickness and the theory utilizing low shear viscosity is of course not new. However, the apparent ability to correlate film thickness using high pressure, high shear rate viscosity is new to this work. This suggests that with the fluids investigated, the non-Newtonian viscous behavior may be governing the fluid behavior in EHD applications.

When considering the effect of the polymer blends investigated, the PAMA had the least effect on film thickness. In fact, the PAMA in naphthenic base oil had virtually no effect on film thickness compared to the base oil alone. In the paraffinic base oil all polymers tended to increase the film thickness above that obtained with the base oil, but only P4, the high percentage (18 percent) low molecular weight (2091) butene polymer, caused any appreciable increase in the film thickness. This is in spite of the fact that P3, P4, P5, and P6 all had approximately the same low shear viscosity (N2 and P2 were lower and N3 higher)

It is clear that the low shear viscosity will not adequately predict the EHD film thickness of polymer blends. It was also found that good data correlation was not obtained when the base oil viscosity of polymer containing oils was used in computing ($U^* \cdot G^*$). However, it is not clear from these results whether the increase in EHD film thickness for P4 over the other solutions is related to differences in molecular weight or polymer type.

Among the synthetic fluids (or bulk polymers) the diester consistently gave the smallest film thickness at any speed and the steepest film thickness vs. speed slope. Its significantly different slope cannot be explained with existing theories. The behavior of the dimethyl silicone seems to be consistent with its power law, pseudo-plastic behavior at the high shear rates encountered in the conjunctive region. The fluorosilicone and the butene polymer gave similar film thicknesses over the range of speeds investigated.

## Acknowledgments

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# APPENDIX A

## Descriptive Data on the Base Fluids and Additives

**A Petroleum Oils: R-620-12 and R-620-15**
**Source: Sun Oil Company**

| | | |
|---|---|---|
| Supplier's designation | R-620-12 | R-620-15 |
| Type | Paraffinic | Naphthenic |
| Symbol used in this study | P1 | N1 |
| Viscosity at 100 °F (cs/SUS) | 33.74/158.0 | 24.06/115.2 |
| Viscosity at 210 °F (cs/SUS) | 5.402/43.95 | 3.728/38.59 |
| Viscosity index (ASTM D-2270) | 103 | −13 |
| Flash point (°F) | 420 | 315 |
| Fire point (°F) | 475 | 365 |
| Pour point (°F) | 5 | −45 |
| Refractive index | 1.4755 | 1.5085 |
| Density at 68 °F (gm/cc) | 0.8602 | 0.9157 |
| Molecular weight[2] | 404 | 305 |
| %C atoms in aromatic rings[3] | 4.0 | 21.5 |
| %C atoms in naphthenic rings[4] | 28.4 | 36.0 |
| %C atoms in paraffinic rings[4] | 67.6 | 42.5 |
| %C atoms in aromatic rings[5] | 3.8 | 20.3 |
| %C atoms in naphthenic rings[5] | 27.7 | 34.5 |
| %C atoms in paraffinic rings[5] | 68.5 | 45.2 |
| Average number of aromatic rings per molecule[5] | 0.18 | 0.77 |
| Average number of naphthenic rings per molecule[5] | 1.66 | 1.74 |
| Average number of total rings per molecule[5] | 1.84 | 2.51 |

**B Polyalkylmethacrylate Additives: PL-4521 and PL-4523**
**Source: Rohm and Haas Company**

| | | |
|---|---|---|
| Manufacturer's designation | PL-4521 | PL-4523 |
| Percent polyalkylmethacrylate in solution | 36.1 | 19.0 |
| Viscosity at 210 °F (cs) | 796 | 773 |
| Viscosity average molecular weight | 560,000 | 1,650,000 |
| Gel permeation chromatograph molecular weight average | 828,000 | 1,510,000 |

**C Polybutene Fluids: LF-5193, LF-5196, and LF-5346**
**Source: American Oil Company**

| | | | |
|---|---|---|---|
| Manufacturer's designation | LF-5193 | LF-5196 | LF-5346 |
| Use in this study | fluid S2 | additive | additive |
| Polymer number average molecular weight | 409 | 2,091 | 25,000 |
| Viscosity at 0 °F (cs) | 18,836 | . . . | . . . |
| Viscosity at 100 °F (cs) | 109 | . . . | 8,041 |
| Viscosity at 210 °F (cs) | 10.6 | 3,325 | 637 |
| Viscosity at 275 °F (cs) | . . . | 765 | . . . |
| Viscosity index (ASTM D-2270) | 87 | . . . | 123.5 |
| Flash point, COC (°F) | 300 | 485 | 400 |
| Unsaturation by hydrogenation (1%) | 91 | 93 | . . . |
| Density at 77 °F (gm/cc) | 0.8443 | 0.9162 | 0.8656 |
| Diluent oil content (%) | 0 | 0 | 80 |
| Diluent oil viscosity at 100 °F (cs) | . . . | . . . | 18 |

**D Diester-Plexol 201 bis-2-ethyl hexyl sebacate: PL-5159**
**Source: Rohm and Haas Company**

| | |
|---|---|
| Manufacturer's designation | PL-5159 |
| Symbol used in this study | S1 |
| Viscosity at −65 °F (cs) | 7,988 |
| Viscosity at 100 °F (cs) | 12.75 |
| Viscosity at 210 °F (cs) | 3.32 |
| Viscosity index (ASTM D-974) | 150 |
| Neutralization number (ASTM D-974) | 0.02 |
| Cloud point (ASTM D-2500) | below −65 |

**E Silicone Fluids: DC-200 and XF1-0294**
**Source: Dow Corning Corporation**

| | | |
|---|---|---|
| Manufacturer's designation | DC-200 | XF1-0294 |
| Symbol used in this study | S3 | S4 |
| Molecular weight | 7,000 | 4,000 |
| Viscosity at 100 °F (cs) | 82.6 | 81.3 |
| Viscosity at 210 °F (cs) | 33.1 | 14.3 |
| Flash point (°F) | 575 | 500 |
| Freeze point (°F) | −67 | −55 |
| Density at 77 °F (gm/cc) | 0.968 | 1.23 |

[2] Calculated from viscosity data using the method of Hirschler, A. E., Journal of the Institute of Petroleum, Vol. 32, 1946, pp. 133–161.

[3] Obtained using the Viscosity-Gravity Constant and the Refractivity Intercept using the method of Kurtz, S. S., Jr., King, R. W., Stout, W. J., and Gilbert, D. J., from a paper, "Relationship between Refractivity Intercept," presented before the Petroleum Div., ACS, Sept. 1955.

[4] *Ibid.*

[5] Calculated using the n-d-M method of structural group analysis of mineral oil fractions of Van Nes and Van Westen, "Aspects of the Constitution of Mineral Oils," Elsevier Publishing Co., Inc., 1951.

# DISCUSSION

## H. E. Sliney[2]

This paper is of considerable interest because it describes EHD studies of sliding contacts lubricated with both Newtonian fluids and non-Newtonian fluids. The pseudoplastic or shear-thinning behavior of oils with polymer additives is clearly demonstrated. The very high contact stress (150 000 psi maximum Hertz) and shear rates ($10^6$ to $10^7$ sec$^{-1}$) employed in the experiments are appropriate if one wishes to simulate conditions in a heavily loaded, high-speed cam or other sliding device with concentrated lubricated contacts.

The experimental results, if hastily interpreted, seem to indicate that the addition of polymer additives to help in maintaining an adequate EHD film is of questionable value. It is clear, for example, that oils containing polyalkylmethacrylate (PAMA) or polybutene (PB) additions gave thinner lubricating films at high shear rates than nonadditive oils of equivalent low shear rate viscosity. However, when comparing a nonadditive oil to the same base oil containing a polymer additive, it is clear that the additive oil provides a thicker film. In other words, high shear rates reduce the effective viscosities of the polymer blends but never down to the viscosity of the base oil.

The authors state in the report that the viscosities of oils with a polymeric additive are reduced at high shear rates to "... a level typical of the polymer type and not the concentration or molecular weight." This statement is not supported by the data. For example, data in Table 2 indicates that a paraffinic oil containing 4 percent PB (mol. wt. = 25,000) suffered a large decrease in high shear rate viscosity while the same base oil containing 18 percent PB (mol. wt. = 2,091) showed no loss in viscosity. This seems to indicate that, for this oil/additive system at least, a large addition or relatively low molecular weight polymer is better than a smaller addition of high molecular weight polymer. Further, if one calculates viscosities at high shear rates from the "apparent EHD viscosity losses" (*S*-values) found in Table 2, using equation 17, one finds that, under high shear rate conditions, the effective viscosity of a paraffinic oil containing 4 percent PAMA (mol. wt. = 560,000) is 83 cp while the same oil with 8 percent

[2] NASA Lewis Research Center, Cleveland, Ohio.

of the additive has an effective viscosity of 127 cp. A 4 percent addition of a higher molecular weight PAMA (mol. wt. = 1,650,000) gives an oil with an effective high shear rate viscosity of 88 cp. All of these data seem to indicate that both the concentration and the molecular weights of the polymeric additives can still be significant at 8 up to $10^6$ to $10^7$ sec$^{-1}$.

The authors also state, "The fluids containing polybutene additives, $P_4$ and $P_5$, do not exhibit the large values of viscosity loss typical of the polyalkylmethacrylates." However, fluid P5 contains 4 percent PB (mol. wt. = 25,000) and has an apparent viscosity loss factor (S-value) of 0.52 compared to only 0.26 for P2 which contains 4 percent of a methacrylate additive. Fluid P4 which contains 18 percent PB (mol. wt. = 2,091) however, is remarkable in that *no* viscosity loss is observed at high shear rates. It cannot be said though that P4 was typical of fluids containing butene additive compared to fluids containing methacrylate additives.

If one were to generalize about the results, it might be correct to say that (with one exception just noted) high shear rates tended to reduce the effective EHD viscosity level to a value characteristic of the base oil rather than of the additive. This statement is a description of the well-known rheological behavior of pseudoplastic or shear-thinning polymer solutions.

## Authors' Closure

Mr. Sliney has contributed a valid and useful discussion which adds to the value of the paper and for this we wish to express our appreciation. As he points out, we are as yet unable to describe the behavior of polymer solutions in elastohydrodynamic contacts in terms of simple catagorizations. His attempt to do so, as represented by his last paragraph, is also incorrect and an over simplification of the case. It does not seem to agree with the observations made in this study and discussed below or with the works of Hamilton and Robertson[3] and Foord, Hammann, and Cameron [12].

It is true that most polymer solutions are pseudoplastic and do shear thin but the viscosity does not always reduce to that of the base oil even at quite high shear rates. This is true both in viscometric data, as we have demonstrated, and in elastohydrodynamic data as demonstrated in this paper. Granted that the interpretation of the latter type of data is more difficult in this respect, both or own data in this paper and that of Hamilton and Robertson[3] seem to show that for some polymer solutions the effective viscosity of the solution in the elastohydrodynamic contact is higher than that of the base oil. However, no clear pattern of behavior has yet emerged.

Some idea of relation between effective viscosity of the polymer solution at high shear rate and the base oil viscosity can be seen by considering the following parameter: $S^* = \mu(\gamma) - \mu_{B0}/\mu_0 - \mu_{B0}$ where $\mu_{B0}$ is the viscosity of the base oil and the other symbols have the same definitions as in the paper. If $S^*$ is unity the solution exhibits no reduction in viscosity at high shear rate and if it is zero the effective viscosity of the solution is that of the base oil. The latter would indicate no influence of the polymer at high shear rates such as those in an elastohydrodynamic contact. The following table shows the $S^*$ for the seven polymer solutions investigated in this paper. The subscript ehd refers to the effective viscosity as determined from the elastohydrodynamic experiment and the subscript vis refers to calculations based on our high pressure viscometer measurements on the same fluids. These are the same methods used in the paper itself. It is significant to note the following:

For the solutions most closely resembling lubricants employed in practice (N2, P2, P3) the shear reduction in the viscometer is about the same (P3) or greater (N2, P2) than occurs in the ehd experiment which is also true of fluid P4. This is significant when considering the relevance of the high pressure viscometric work we are conducting. The solutions for which there is a larger shear reduction in the elastohydrodynamic data than the viscometric data are those containing the very high molecular weight (1.6 × $10^6$ awu) PAMA which is not commonly used in lubricants where ehd type conditions exist because of mechanical shear degradation problems.

| | $S^*_{ehd}$ | $S^*_{vis}$ |
|---|---|---|
| N2 | 0.29 | 0.05 |
| N3 | 0.03 | 0.24 |
| P2 | 0.50 | 0.32 |
| P3 | 0.33 | 0.36 |
| P4 | 1.00 | 0.87 |
| P5 | 0.33 | 0.58 |
| P6 | 0.19 | 0.51 |

[3] Hamilton, G. M., and Robertson, W. G., "Lubrication of Rollers With Oils Containing Polymers," *Proceedings of the Institution of Mechanical Engineers*, Vol. 181, Part 3, paper No. 3, 1966–1967.

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# Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts With Transient Loading: 2—Traction

*This paper describes the results of the traction measurements obtained in the experiment discussed in the companion paper entitled "Fluid Rheological Effects in Sliding Elastohydrodynamic Point Contacts With Transient Loading: I.—Film Thickness." Under the conditions investigated, the traction values appear to be primarily a function of the sliding velocity. Large variations in fluid composition and inlet viscosity had little influence on the tractive force. It was also found that rapid application of the normal load had a negligible effect on the traction.*

## Introduction

This paper discusses traction measurements recently made in a study of EHD point contacts in pure sliding. The traction measurements were made during and following a step-loading transient between the bearing surfaces. In addition, the center line and minimum film thicknesses were simultaneously obtained. The results of that investigation are given in the companion paper [1, 2].[1]

### Experimental Variables

The approximate step load applied to the bearing is characterized by a steady-state maximum of 15 ± $^1/_2$ lbf and a loading rate such that the instantaneous load $W(t)$ reached 95 percent of $W_m$ in 0.040–0.050 sec. The same value $W_m$ was used in each experiment once it was found that the steady state traction coefficient $TC$ varied only slightly with normal load. This is similar to the small dependence of EHD film thickness on load predicted by analysis [3, 4] and observed experimentally [1, 2, 5, 6].

Sliding velocities of 13.7, 27.4, 54.9, and 92.1 in. per sec were used with each lubricant. The minimum value is the velocity at which the lowest viscosity lubricant can maintain a continuous protective film. The maximum value is the velocity at which it became difficult to maintain sufficient lubricant in the contact inlet to sustain a continuous film for the most viscous lubricant. The continuity of the oil film was determined by observations made in connection with film thickness measurements [1].

The lubricants selected for examination were chosen on the basis of having a range of properties known to be influential in film-thickness analysis [3, 4]. The selected lubricants had a considerable range in the values of pressure-viscosity exponent $\alpha$, the ambient, low shear viscosity $\mu_0$, and a variety of lubricant chemistries. Viscosity data as a function of pressure, temperature, and shear stress were obtained for the fluids examined in this study by Novak and Winer [7, 8, 9]. Viscosity measurements were made at pressures up to 80,000 psi and at shear rates up to $10^4$ sec$^{-1}$ at the higher pressures examined. For the conditions imposed in this study, the mean hydrodynamic pressure in the EHD contact is expected to be approximately 100,000 psi and the mean shear rate in the lubricant film to be $10^6$–$10^7$ sec$^{-1}$. Novak and Winer's data were taken at conditions more nearly representative of those in the EHD contact than any other currently available. The thirteen fluids selected for this study are listed in Table 1. Detailed descriptions of the base fluids and additives are given in Appendix A of the companion paper [1].

**Table 1 Experimental fluids**

| | |
|---|---|
| Naphthenics | |
| N1 | Naphthenic base oil (R-620-15) |
| N2 | N1 + 4% polyalkylmethacrylate (PL-4521) |
| N3 | N1 + 4% polyalkylmethacrylate (PL-4523) |
| Paraffinics | |
| P1 | Paraffinic base oil (R-620-12) |
| P2 | P1 + 4% polyalkylmethacrylate (PL-4521) |
| P3 | P1 + 8% polyalkylmethacrylate (PL-4521) |
| P4 | P1 + 18% polybutene (LF-5196) |
| P5 | P1 + 4.4% polybutene (LF-5346) |
| P6 | P1 + 4% polyalkylmethacrylate (PL-4523) |
| Synthetics | |
| S1 | Diester-Plexol 201 bis-2-ethyl hexyl sebacate (PL-5159) |
| S2 | Polybutene (LF-5193) |
| S3 | Dimethylsiloxane (DC-200) |
| S4 | Trifluoropropylmethylsiloxane (XF1-0294) |

### Experimental Technique and Equipment

Because of optical requirements imposed by the film-thickness measurement system, the EHD contact was formed by a chromium-steel sphere loaded and rotated against a synthetic sapphire

[1] Numbers in brackets designate References at end of paper.

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disk (see Fig. 1). Also, because of optical considerations, the lower surface of the sapphire has a vacuum deposited layer of Inconel. The boundaries of the EHD contact are, therefore, both metallic. The sphere has a diameter of 1.250 in. and a surface finish of one microin. rms. The synthetic sapphire is 0.125 in. thick and 1.00 in. in dia. In addition, this disk is flat to within an eighth of a wavelength.

The sphere is rotated by a flexible coupling cemented to the back side of the sphere as positioned in Fig. 1. The sphere is supported and loaded against the sapphire disk by a bearing block containing three small radial ball bearings. In order to maintain a nearly constant sliding velocity while the normal load and, hence, the torque on the drive mechanism was rapidly changing, a significant amount of inertia was incorporated into the drive mechanism. In addition, a hysteresis synchronous motor was used to rotate the sphere. This required that gears be used to change rotational speeds.

As shown in Fig. 1, the normal load is applied pneumatically by rapidly pressurizing the bellows located beneath the sphere support to a predetermined level. The strain gage load cell located below the bellows gives the instantaneous value of the normal load $W(t)$. The sphere, sphere support, bellows, and normal force load cell are mounted in series on an air bearing. The air bearing provides a substantial amount of rigidity in the vertical direction, but allows frictionless movement along a line parallel to the sliding velocity in the EHD contact.

During load steady conditions, the air bearing and the sphere have been displaced to the right in Fig. 1 in response to the traction force $f$ in the EHD contact. Since the friction force in the air bearing is assumed to be insignificant, the force on the traction load cell shown in Fig. 1 is taken to be equal to the traction force. The only other horizontal forces acting on the air bearing system are due to very small bending moments in the flexible coupling rotating the sphere and the gas supply tube attached to the loading bellows. Since the total displacement of the air bearing assembly in response to a tractive force is less than 0.050 in. from left to right, the forces resulting from these two bending moments have been found to be negligible.

During the application of the normal load ($0 < t < 0.05$ sec) the traction load cell can be used to obtain traction data, but its signal does not represent this value directly. The strain gages sense the deflection of the cantilever beam and not the traction force in the EHD contact. The actual traction force $f(t)$ can be related to the apparent force $f'(t)$, as sensed by the load cell by the equation

$$f(t) = f'(t) + c\dot{x} + m\ddot{x} \qquad (1)$$

where $x$ is the displacement of the air bearing system, $m$ is its mass, and $c$ is a damping coefficient associated with the motion of the air bearing system under zero traction conditions. The output of the traction load cell $f'(t)$ along with that of the normal force load cell $W(t)$ were displayed on a dual-beam oscilloscope and photographed. Since the force measured by the traction load cell $f'(t)$ is proportional to the displacement $x$, i.e.,

$$f'(t) = kx \qquad (2)$$

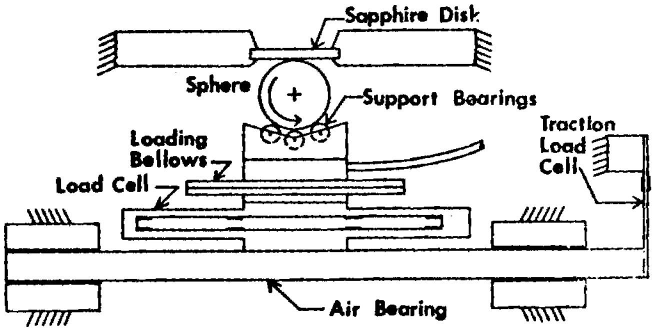


**Fig. 1 Schematic diagram of the experimental equipment**

the photograph of $f'(t)$ also represents $x(t)$. Having the function $x(t)$, standard numerical techniques [10] were employed to compute $\dot{x}(t)$ and $\ddot{x}(t)$. The values $k$, $c$, and $m$ remained constant throughout the study and their values were determined by independent calibration. With this information, equation (1) was used to obtain the actual traction force $f(t)$. Dividing this value by the instantaneous load $W(t)$, also obtained from the photograph, gave the instantaneous traction coefficient $TC(t)$. In most cases, the values of $c\dot{x}$ were insignificant compared to the other terms in equation (1). The values of $m\ddot{x}$, however, could not be made relatively small without considerable added expense. The value of $m$ is limited by the needed rigidity of the air bearing. The numerical procedure used for predicting $f(t)$ from $x(t)$ and its derivatives was tested using data points taken from the analytical solution to equation (1) for a ramp input between $W = 0$ and $W = W_m$. A ramp of 0.050 sec duration closely approximates the loading transient used in this study. If a sufficient number of values of $x(t)$, $\dot{x}(t)$, and $\ddot{x}(t)$ were used, the numerical procedure adequately predicted the step input.

As yet it is not possible to determine the temperature distribution of the lubricant in the EHD contact. The temperature of the lubricant near the contact inlet was reliably determined, however. It was obtained by placing a 0.001-in-dia-thermocouple in the inlet region at a point 0.045 in. from the beginning of the Hertzian contact zone. This thermocouple consistently measured a temperature equal to that of the fluid in the lubricant reservoir or up to 1 deg F greater. The temperature rise was detected only after the experiment had been in progress several seconds. During the time period of load application (0.050 sec), the inlet temperature is assumed to remain constant and equal to that measured at $t = 0$. This assumption appears reasonable since the sphere has not completed one revolution during this time period and the lubricant entering the contact is, therefore, essentially at the constant temperature of the lubricant being supplied to the contact inlet from the reservoir.

## Typical Results

The time variation of the traction coefficient $TC(t)$ during and after the loading transient was plotted for the 51 experi-

## Nomenclature

- $A$ = area of the Hertzian contact
- $c$ = damping constant
- $f$ = traction force
- $f'$ = apparent traction force = $k.x$
- $h_c$ = center line film thickness
- $H_c^*$ = center line film thickness parameter = $h_c/R$
- $h_m$ = minimum film thickness
- $k$ = cantilever load cell spring constant
- $m$ = mass of the air bearing system
- $P$ = pressure
- $R$ = radius of the sphere
- $t$ = time
- $TC$ = traction coefficient = $f/W$
- $U$ = sliding velocity
- $W$ = normal load
- $W_m$ = maximum or steady state normal load
- $x$, $\dot{x}$, $\ddot{x}$ = air bearing displacement, velocity, and acceleration
- $\alpha$ = pressure—viscosity exponent
- $\dot{\gamma}$ = shear rate
- $\gamma, \delta$ = numerical constants
- $\mu$ = viscosity
- $\mu_0$ = viscosity at ambient pressure and temperature
- $\bar{\tau}$ = mean shear stress

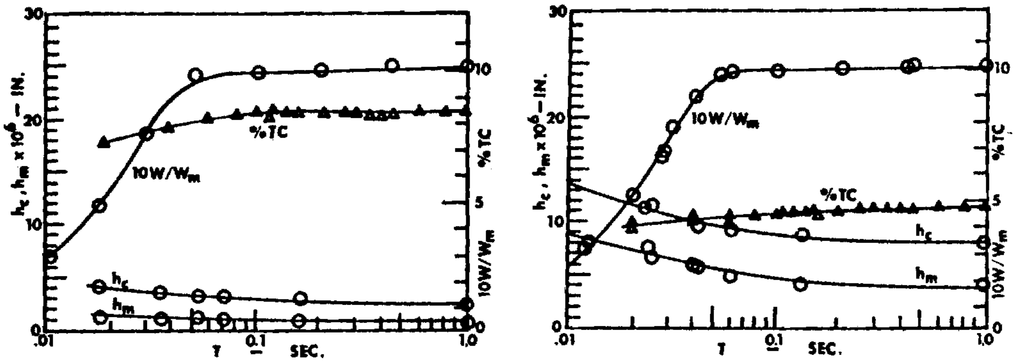


Fig. 2 Time variation of $W/W_m$, $TC$, $h_c$, and $h_m$ for Fluid N3 at (a) 13.7 in/sec and (b) 92.1 in/sec.

ments performed in the manner shown in Fig. 2. The variation of the $W/W_m$, $h_c$, $h_m$, and $TC$ for naphthenic fluid N3 at the lowest and highest sliding velocity is shown in that figure. In all cases, the steady-state traction coefficient decreases with increasing sliding velocity for a given fluid. It is also apparent that the traction coefficient increases slightly during the load application. Traction data computed from equation (1) for $t < 0.020$ sec proved to be unreliable since the acceleration term $m\ddot{x}$ completely dominates the apparent traction force $f'(t)$ in equation (1). A small increase in the traction coefficient approximately one second after the beginning of the experiment occurs at the same time that the center line film thickness begins to drop slightly. These trends are believed to be a result of a gradual increase in the temperature of the lubricant at the bearing inlet.

## Discussion of Results

### Steady State Traction Measurements

The variation of $TC$ with sliding velocity is shown in Figs. 3–5. The curves shown in these figures are similar to the traction data for sliding contacts obtained by Plint [11]. In the film thickness experiments, it was found that the data of a given class of fluids could be correlated using the velocity parameter $U^*$ rather than the sliding velocity itself. Figs. 3–4 indicate that there is little difference in the traction coefficients of a class of fluids when plotted in terms of $U$. This means that the ambient viscosity is not important in determining the traction coefficient. It can be seen that the steady-state traction coefficients for a given velocity $U$ do not change by more than 10 percent within a given class of fluids. At a sliding speed of 27.4 in/sec, for example, the naphthenic base oil N1 ($\mu_0$ = 45 cp) will yield a steady state traction coefficient of 0.072. The same fluid with a 4 percent concentration of 560,000 molecular weight polyalkylmethacrylate ($\mu_0$ = 101 cp) will yield a traction coefficient of 0.070. Fluid N3 with a 4 percent concentration of 1,650,000 molecular weight polyalkylmethacrylate produces a traction coefficient of 0.068 with an inlet viscosity of 369 cp. The above examples are typical of the small degree of deviation in traction data for paraffinic and naphthenic fluids at all sliding velocities.

The data in Figs. 3–5 indicate that a factor of eight difference in inlet viscosity (N1 versus N3, for example) only slightly affects the measured values of traction coefficient. This would seem to imply that the effective viscosities of the three naphthenic fluids, for example, are approximately the same, equal to that of the base oil. The same is true of the paraffinic fluids. However, the

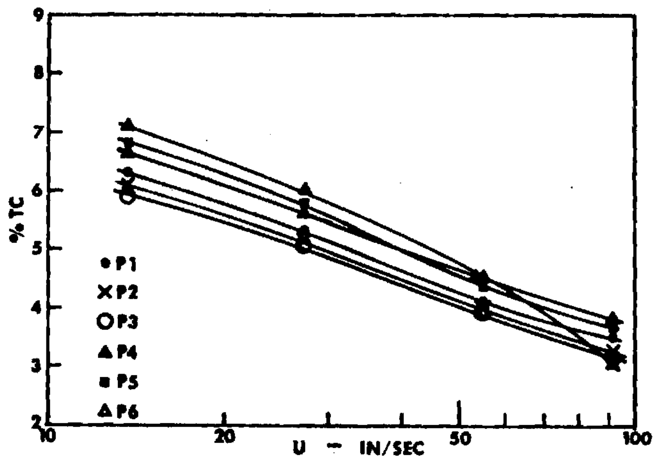


Fig. 4 Variation of traction coefficient with velocity-paraffinic fluids

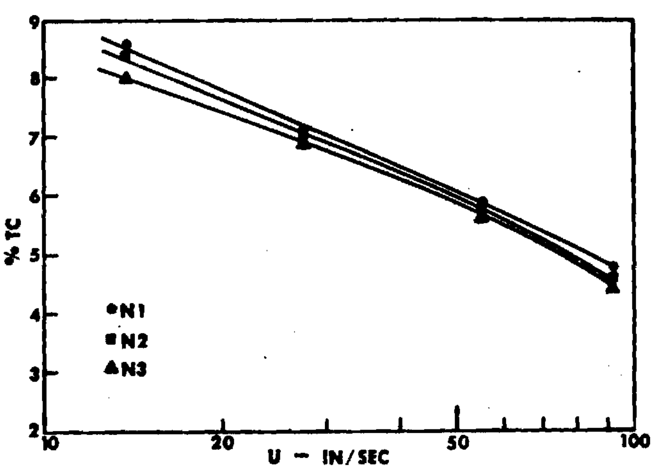


Fig. 3 Variation of traction coefficient with velocity-naphthenic fluids

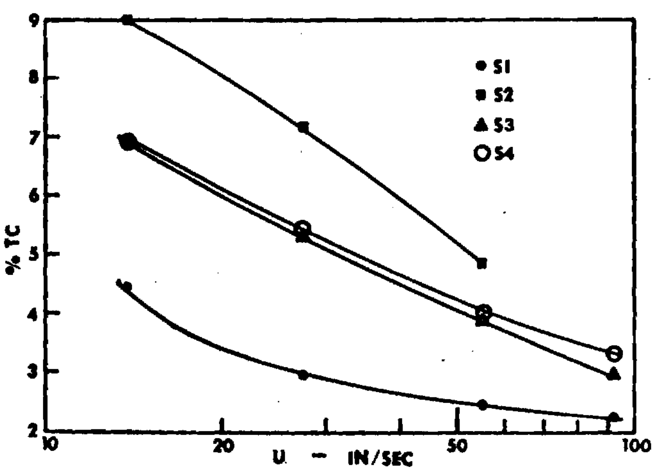


Fig. 5 Variation of traction coefficient with velocity-synthetic fluids

corresponding values of the center line film thickness must also be considered before the actual reduction in viscosity can be estimated. The traction in the EHD sliding contact is a function of the shear stress at the bearing surfaces. The shear stress in turn is determined by the lubricant viscosity and the fluid velocity profile. The center line film thickness is influential in establishing that velocity profile. The film thickness measurements [1] indicated that there is little variation in the center line film thickness for fluids of a given class at a selected sliding velocity $U$. For example, at 92.1 in/sec, the naphthenic fluids N1, N2, and N3 produced center line film thickness parameters $H_c^*$ of 12.3, 14.5, and 14.5, respectively. Except for fluid P4, the paraffinic fluids behaved similarly. For example, at 92.1 in/sec, fluids P1, P2, P3, P5, and P6 produced center line film thickness parameters $H_c^*$ of 13.7, 16.0, 19.2, 18.7, and 15.7, respectively. Fluid P4 is a paraffinic oil containing a high concentration (18 percent) of a low molecular weight (2091) butene polymer. This fluid did not experience an apparent viscosity loss on the basis of film thickness data correlation [1]. Since the fluids of a given class produce comparable center line film thicknesses at a given sliding velocity, the velocity profiles, and hence the shear rates, are likely to be similar. If both the shear rates and the traction coefficients for fluids having the same base oil are nearly equal, the effective viscosity in the contacts must also be similar. The conclusion is that the viscosities of lubricants having the same base oil are being reduced to approximately the same value, namely that of the base oil at an elevated temperature.

It is difficult to compare traction behavior between synthetic fluids because of the obvious difference in chemical structure. The shapes of steady-state traction curves are similar, however, to curves for the naphthenic and paraffinic oils.

**Transient Traction Measurements**

The effects of rapid load application on the observed tractive force appear to be minimal. The steady state and transient traction and film thickness values corresponding to the same instantaneous load were compared for S2, the fluid giving the most deformation in squeeze film studies [1]. Fig. 6 shows the time variation of $W/W_m$, $TC$, $h_c$, and $h_m$ for $W_m \simeq 26$ lbf with a loading time of approximately 0.050 sec. The values of $TC$, $h_c$, and $h_m$ plotted at $t = 0.0066$ sec and $t = 0.024$ sec were obtained from the steady state data of separate experiments in which $W_m = 4.7$ lbf and $W_m = 15.7$ lbf, respectively. Fig. 6 shows that the steady-state values of the traction coefficient (symbol $\Delta$) at $W = 4.7$ lbf and 15.7 lbf are less than 10 percent higher than the corresponding values at the same instantaneous loads during the load transient. This indicates that rapid load application has only a slight effect, if any, on the traction. Because of the numerical procedures needed to obtain transient traction data, the maximum probable error in the calculated tractive force is estimated to be about 5 percent. Therefore the steady state and transient traction coefficients in Fig. 6 may be in closer agreement than indicated.

By plotting the traction data in the form shown in Fig. 2, it was observed that, in all cases, the traction coefficient increased slightly between $t = 0.020$ sec and $t = 0.060$ sec and then remained essentially constant. It is believed that this increase, rather than a decrease or constant value, can be predicted on the basis of steady state behavior, ignoring effects of rapid load application. Assuming that

$$f \propto \bar{\tau} \cdot A \tag{3}$$

where $\bar{\tau}$ is an average shear stress in the contact, and that the shear rate may be approximated by

$$\dot{\gamma} \simeq U/h_c \tag{4}$$

a Newtonian lubricant will yield a traction dependence given by

$$f \propto \frac{\mu U A}{h_c} \tag{5}$$

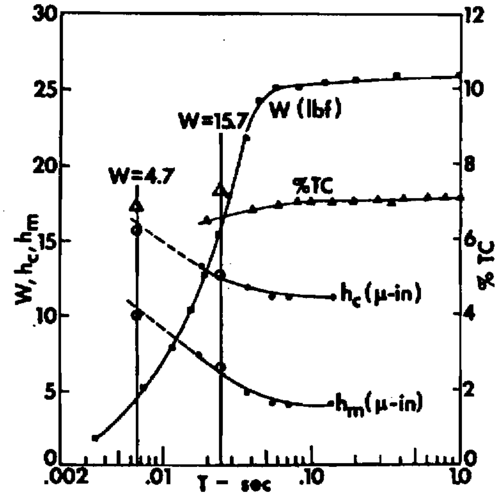


**Fig. 6 Time variation of film thickness and traction during a loading transient**

Using the exponential pressure-viscosity relation and the steady-state dependence of $h_c$ on $W$ given by Dowson and Higginson [4], the above relation becomes

$$f \propto \frac{\mu_0 e^{\alpha P} \cdot U \cdot A}{W^{-0.11}} \tag{6}$$

Assuming that the pressure in equation (6) is equal to the mean Hertzian pressure and the area $A$ is equal to the Hertzian contact area for the instantaneous load $W$

$$f \propto \frac{\mu_0 U e^{\alpha\gamma W^{1/3}} (\delta\pi W^{2/3})}{W^{-0.11}} \tag{7}$$

where $\mu_0$, $U$, $\gamma$, and $\delta$ are constants for a given experiment. Equation (7) may then be simplified to

$$f \propto e^{\alpha\gamma W^{1/3}} \cdot W^{0.80} \tag{8}$$

In terms of the traction coefficient $TC$,

$$TC = \frac{f}{W} \propto e^{\alpha\gamma W^{1/3}} \cdot W^{-1/5} \tag{9}$$

The term $\gamma$ is defined by

$$\gamma = \frac{1}{\pi}\left(\frac{2E'}{3R}\right)^{2/3} = 3.8 \times 10^4 \text{ lbf}^{-2/3} - \text{in.}^{-2} \tag{10}$$

where $E' = 38.4 \times 10^6$ lbf/in.$^2$ is the reduced modulus of the sapphire-steel system. Assuming that $\alpha$ is also constant, equation (9) may be differentiated to obtain

$$\frac{\partial TC}{\partial W} \propto e^{\alpha\gamma W^{1/3}}\left[-\frac{W^{-6/5}}{5} + \frac{\alpha\gamma W^{-13/15}}{3}\right] \tag{11}$$

Dividing equation (11) by equation (9) the proportionality may be changed to an equality

$$\frac{1}{TC}\frac{\partial TC}{\partial W} = \frac{\partial \ln TC}{\partial W} = \frac{-1}{5W} + \frac{\alpha\gamma}{3W^{2/3}} \tag{12}$$

Several sets of traction data similar to that shown in Fig. 2 were examined, and it was found that at $W = 10$, approximately the middle of the loading transient during which traction measurements were possible (see Fig. 2), the quantity $\partial \ln TC/\partial W$ has experimental values in the range of 0.01–0.03. Equation (12) will predict values of this range if

$$0.11 \times 10^{-4} < \alpha < 0.18 \times 10^{-4} \text{ in.}^2/\text{lbf} \tag{13}$$

In general, the lubricants studied had ambient values of $\alpha$ on the order of $1.0 \times 10^{-4}$ in²/lbf, obtained from the capillary viscometer data of Novak and Winer [7, 8, 9]. Their studies also indicate that $\alpha$ decreases with both increasing temperature and pressure for some fluids at elevated temperature. The ASME Pressure-Viscosity Report [12] also indicates this trend for typical naphthenic and paraffinic oils. The value is as low as $0.3 \times 10^{-4}$ in²/lbf for paraffinic fluids and $0.5 \times 10^{-4}$ in.²/lbf for naphthenic fluids at a pressure of $10^5$ lbf/in² and a temperature of 425 deg F. Equation (12), therefore, will predict the approximate traction coefficient dependence on normal load simply from quasi-steady considerations if the rheological property $\alpha$ is evaluated at the high levels of temperature and pressure expected in the sliding contact.

The authors recognize that this analysis may be a highly simplified description of the EHD traction phenomena, but it has the advantage of being physically plausible and capable of predicting numerical values that agree with a measured EHD quantity (namely, the dependence of traction on load) when measured lubricant properties (pressure-viscosity coefficients) are used.

## Conclusions

This investigation encompassed a more realistic set of operating conditions than previous EHD experiments in that a maximum Hertzian stress of 150,000 psi was attained at the completion of a 0.045 sec loading transient during which the film thickness interference patterns, total normal load, and the tractive force were all recorded. Hydrocarbon fluids, polymer containing hydrocarbon solutions, and bulk polymer lubricants were investigated.

The steady state traction coefficient in the sliding EHD contact for 51 normal load-sliding velocity combinations were reported. It was also found that the effects of the rapidly applied normal load were minimal and that the slight increase in traction as the normal load was applied could be predicted using quasi-steady analysis.

It was also found that the addition of high molecular weight polymers to the naphthenic and paraffinic base oils caused only a slight increase in the traction. All fluids exhibited the trend of a decreasing traction coefficient with increasing sliding speed, a relation observed by other investigators of EHD sliding contacts for these sliding speeds.

## Acknowledgments

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# DISCUSSION

## A. Gu[2] and J. Walowit[3]

The authors are to be congratulated for presenting some interesting traction data under high load and pure sliding conditions. However, the discussers are concerned with the traction analysis developed by the authors to interpret the data.

First of all, in the analysis the mean Hertzian pressure is used to calculate the contact zone shear stress (see equation (6)). This introduces an error in the coefficient of traction-load relationship, within the isothermal and Newtonian assumptions adopted by the authors. Neglecting thermal effects, the traction in a circular contact for a Newtonian lubricant is

$$f = \int_0^a \frac{2\pi U \mu_0 e^{\alpha p_{HZ}} \sqrt{1 - \left(\frac{r}{a}\right)^2}}{h}\, rdr \qquad (14)$$

where $a$ is the radius of contact circle, $p_{HZ}$ is the maximum Hertz pressure, and other symbols are consistent with the Nomenclature of the paper. The above equation can be integrated to give

$$f = \frac{2A\mu_0 U}{h} \left\{ \frac{1}{\lambda^2} \left[ e(\lambda - 1) + 1 \right] \right\} \qquad (15)$$

where $\lambda = \alpha p_{HZ}$. For $\lambda \gg 1$,

$$f = \frac{2A\mu_0 U e^{\alpha p_{HZ}}}{h \alpha p_{HZ}} \qquad (16)$$

For a set of experiments in which load is the only variable, the coefficient of traction varies with load as follows:

$$TC \propto e^{1.57 W^{1/3}} W^{-0.54} \qquad (17)$$

By comparing the above with equation (9) of the paper the error caused by using mean Hertzian pressure is apparent.

The data presented in Figs. 3, 4, and 5 show that traction decreases rapidly with increasing sliding speeds. This indicates that thermal effects are very important in the sliding speed range studied. To illustrate this, the discussers have calculated the temperature rise for sliding speed of 92.1 in/sec, using the elastohydrodynamics computer program given in the report by McGrew, et al.[4] It was found that the maximum mean fluid temperature rise in the contact is 300 deg F for $W = 26$ lb. The large temperature rise in the contact zone is recognized by the authors as they suggest using lowered values of the pressure-viscosity coefficient $\alpha$ under high pressure and high temperature conditions. They mentioned that values of $\alpha$ as low as $0.5 \times 10^{-5}$ in²/lb were extracted from ASME viscosity data for naphthenic fluids at 425 deg F and $10^5$ psi. The value of $\alpha$ needed to fit their measurements is about $0.15 \times 10^{-4}$ in²/lb. However, the discussers find, from the ASME viscosity data, that values of $\alpha$ for naphthenic fluids at 425 deg F and $10^5$ psi range from $0.47 \times 10^{-4}$ to $0.66 \times$

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[3] Senior Research Scientist, Mechanical Technology Inc.

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$10^{-4}$ in²/lb, which are well above the needed value to best fit the traction-load slope. It is believed that this discrepancy is largely due to the isothermal approximation used in the authors' analysis.

## J. W. Kannel[5] and W. R. D. Wilson[5]

We found the authors paper quite interesting since we are deeply involved in studying lubricant rheology in rolling-sliding contact-conditions of the type seen in real machine elements. In this regard the general approach taken by the authors is the type that can yield significant information about lubricant rheology.

In this type of experiment it is, of course, imperative that the temperatures in the inlet zone, as well as in the contact zone, between the lubricated elements be known. For this reason we have used rolling-sliding contacts[6] in our rheological experiments rather than pure-sliding contacts. In this type of experiment, the rolling motion generates the lubricant film and the sliding motion generates only the tractions, hence very low sliding conditions can be used and thermal effects can be minimized.

A simple inlet temperature measurement is not necessarily a reliable method for detecting disk temperature. For example, we have used such a thermocouple arrangement, but in addition we used a low vacuum to aspirate the lubricant clinging to the disk over the couple. This temperature was consistently different than detected by the thermocouple used without the vacuum. Elusive temperatures then may well have caused the viscosities of the fluids to be the same as the base fluid which is consistent with the authors comments. However, this conclusion could be reached simply from the film-thickness measurements obtained earlier in their program since film thickness is nearly as sensitive to inlet viscosity ($h \sim [\mu_0]^{8/11}$) as is traction.

It is not surprising that the authors did not observe any transient traction effects with this type of apparatus. The residence time in the contact zone of a fluid element on the ball will be much less than 100 microseconds or less than a 1/100 of the "transient" loading time. That is, a fluid element is inherently subjected to transient loadings at a rate two orders of magnitude faster than the externally applied loading. To a fluid element in the contact zone, then, the authors transient loading was extremely steady. It can be noted that realistic external transient loading in machine elements such as gears will be less than 1 millisecond. So caution must be exercised in drawing any general conclusion from the type of transient loading studies presented in the paper.

Finally, we find Fig. 6 extremely interesting because it shows a rather sizable change in film thickness with loading. This is especially true of the minimum film thickness $h_m$. For example, the load in going from 4.7 lb to 15.7 lb causes a Hertz pressure increase of about 50 percent. For this level of pressure changes normal EHD theory would predict a film thickness change of only 7.6 percent which is much less than shown in Fig. 6. However, this level of film thickness change, shown in Fig. 6, is consistent with the measurements we have made using an X-ray technique.[7] Further papers and discussions on this subject should prove to be quite interesting.

[5] Battelle's Columbus Laboratories, Columbus, Ohio.

[6] Bell, J. C., Kannel, J. W., Allen, C. M., of Battelle Memorial Institute "The Rheological Behavior of the Lubricant in the Contact Zone of a Rolling Contact System," *Journal of Basic Engineering*, TRANS. ASME, Series D, Vol. 86, No. 3, Sept. 1964, pp. 423–425.

[7] Kannel, J. W., and Bell, J. C., "Interpretations of the Thickness of Lubricant Films in Rolling Contact. I. Examination of Measurements Obtained by X-Rays. II. Influence of Possible Rheological Factors," to be published.

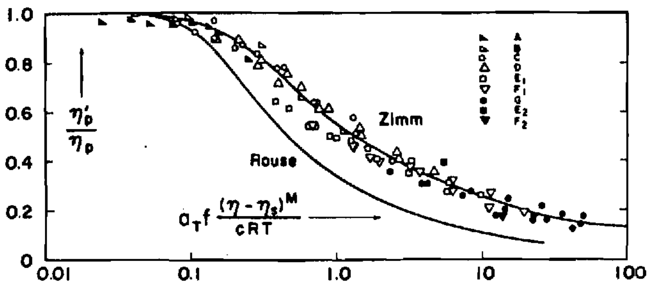


**Fig. 7 Dynamic viscosity versus dimensionless shear rate for polystyrene solutions**

## E. G. Trachman[8] and H. S. Cheng[8]

In the last few years a number of significant data have been gathered for traction in elastohydrodynamic rolling and sliding contacts. The authors' contribution is certainly another interesting addition, particularly for pure sliding contacts.

The question of transient effects due to a rapidly applied normal load on film thickness as well as friction has often been raised. It is gratifying to see that the authors results have indicated such effects are indeed negligible. It would seem that the significance of transient effects can be readily estimated by comparing the loading time and the actual transit time through the contact.

For example, based on the data presented in the paper, the transit time for a particle of fluid to travel through the Hertzian contact zone can be calculated to be of the order 0.2 millisec. Comparing the 50 millisec it takes the applied load to reach 95 percent of its steady-state value to this transit time, it is not surprising that the results are not influenced by the seemingly rapid loading.

The authors have also found that the addition of high molecular weight polymers to the naphthenic and paraffinic base oils caused only a slight increase in the traction. It is well known that the viscosity of polymer solutions fall off and approach the viscosity of the base oil as the shear rate increases.

For example, Lamb and Matheson[9,10] investigated the effect of shear rate on the viscosity of the polymer solution using an oscillatory crystal. Fig. 1 shows that the value of shear rate at which the polymer solution approaches that of the base oil depends upon the molecule weight and concentration of the polymer additive. We have calculated that all of the polymer solutions used by the authors would be over-relaxed and the viscosity of the solution will be close to the viscosity of the base oil at shear rates greater than $10^5$ sec$^{-1}$. Since the average shear rates for the authors experiments are $10^6$–$10^7$ sec$^{-1}$, this would explain why the polymer additives had very little effect.

We fully agree with the authors that an analytical model based on the assumption of an isothermal film and an exponential pressure-viscosity relation is grossly simplified. The fact that traction decreases with increasing sliding speed shows that the traction in the region of their experiment is largely dominated by the limiting shear stress. It is not governed by the laws of a Newtonian lubricant.

## Authors' Closure

We appreciate the discussions presented and believe that they add to the value of the paper.

[8] Graduate Student and Associate Professor, respectively, Department of Mechanical Engineering and Astronautical Sciences, Northwestern University, Evanston, Ill.

[9] Lamb, J., and Matheson, A. J., *Proceedings Royal Society* (London), Series A, Vol. 281, 1964, p. 207.

[10] Harrison, G., Lamb, J., and Matheson, A. J., *Journal of Physics and Chemistry*, Vol. 68, 1964, p. 1072.

With regard to Messrs. Gu and Walowitt's comments we must point out that in our analysis we were only looking for trends and, therefore, took a very simplified approach. Granted there is some difference between our simplified analysis and their simplified analysis, the trends of traction coefficient with load appear to be similar.

The only other point in the discussions that we wish to comment on is the statement by Messrs. Trachman and Cheng where they say that "it is well known that the viscosity of a polymer solution falls off and approaches the viscosity of the base oil as the shear rate increased." We would like to answer this by directing attention to the discussion and closure of the preceding and companion paper in which this point is discussed. It is true, however, that the viscous behavior of polymer solutions may be different in the more severe contact region controlling traction than in the inlet region which appears to control film thickness. The traction results of this paper suggest that the effective viscosity of the solution does decrease to that of the base oil in the contact region.

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Appendix D-1

1318-88-1,100F,CAP4,7-13-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5194. | .2625+00 | .2843+05 | .1071+00 | .1271+03 | .7461+04 | .7914+01 |
| 100-2 | 5194. | .2546+00 | .3843+05 | .1956+00 | .1667+03 | .9785+04 | .1103+02 |
| 100-3 | 5194. | .2849+00 | .4422+05 | .2590+00 | .2147+03 | .1260+05 | .1134+02 |
| 100-4 | 5155. | .2742+00 | .3633+05 | .1748+00 | .1697+03 | .9959+04 | .9680+01 |
| 100-5 | 5155. | .2833+00 | .3633+05 | .1748+00 | .1753+03 | .1029+05 | .9368+01 |
| 100-6 | 5155. | .2757+00 | .5897+05 | .4605+00 | .2769+03 | .1626+05 | .1563+02 |
| 100-7 | 11354. | .4369+00 | .2053+05 | .5584-01 | .1528+03 | .8971+04 | .3433+01 |
| 100-8 | 11334. | .4943+00 | .2685+05 | .9549-01 | .2261+03 | .1327+05 | .3966+01 |
| 100-9 | 11334. | .4714+00 | .2580+05 | .8815-01 | .2072+03 | .1216+05 | .3998+01 |
| 100-10 | 11373. | .4633+00 | .2369+05 | .7434-01 | .1870+03 | .1098+05 | .3736+01 |
| 100-11 | 11373. | .4892+00 | .3317+05 | .1457+00 | .2765+03 | .1623+05 | .4953+01 |
| 100-12 | 11373. | .4842+00 | .4317+05 | .2469+00 | .3562+03 | .2091+05 | .6513+01 |
| 100-13 | 11373. | .4634+00 | .3475+05 | .1599+00 | .2744+03 | .1610+05 | .5478+01 |
| 100-14 | 11373. | .4946+00 | .8687+05 | .9995+00 | .7320+03 | .4296+05 | .1283+02 |
| 100-15 | 11373. | .4324+00 | .1321+06 | .2313+01 | .9734+03 | .5713+05 | .2233+02 |
| 100-16 | 11373. | .4662+00 | .1100+06 | .1604+01 | .8739+03 | .5130+05 | .1724+02 |
| 100-17 | 11373. | .4374+00 | .1364+06 | .2463+01 | .1016+04 | .5965+05 | .2277+02 |
| 100-18 | 11373. | .4710+00 | .7108+05 | .6691+00 | .5704+03 | .3348+05 | .1102+02 |
| 100-19 | 19766. | .8960+00 | .1326+05 | .2328-01 | .2024+03 | .1188+05 | .1081+01 |
| 100-20 | 19766. | .9631+00 | .1980+05 | .5191-01 | .3248+03 | .1907+05 | .1502+01 |
| 100-21 | 19766. | .9327+00 | .2107+05 | .5879-01 | .3348+03 | .1965+05 | .1650+01 |
| 100-22 | 19766. | .9867+00 | .1962+05 | .5096-01 | .3298+03 | .1936+05 | .1452+01 |
| 100-23 | 19841. | .9747+00 | .1744+05 | .4027-01 | .2896+03 | .1700+05 | .1307+01 |
| 100-24 | 19841. | .9849+00 | .2434+05 | .7846-01 | .4084+03 | .2397+05 | .1805+01 |
| 100-25 | 19766. | .9668+00 | .1380+05 | .2524-01 | .2274+03 | .1335+05 | .1043+01 |
| 100-26 | 19766. | .9677+00 | .2561+05 | .8687-01 | .4222+03 | .2478+05 | .1933+01 |
| 100-27 | 19841. | .9141+00 | .3160+05 | .1323+00 | .4922+03 | .2889+05 | .2526+01 |
| 100-28 | 19841. | .9407+00 | .4613+05 | .2819+00 | .7394+03 | .4340+05 | .3583+01 |
| 100-29 | 19841. | .9768+00 | .5522+05 | .4038+00 | .9189+03 | .5393+05 | .4130+01 |
| 100-30 | 19841. | .9218+00 | .6838+05 | .6194+00 | .1074+04 | .6304+05 | .5420+01 |
| 100-31 | 29791. | .2066+01 | .1335+05 | .2360-01 | .4699+03 | .2758+05 | .4721+00 |
| 100-32 | 29791. | .2124+01 | .1399+05 | .2591-01 | .5061+03 | .2971+05 | .4810+00 |
| 100-33 | 29791. | .2112+01 | .1437+05 | .2736-01 | .5172+03 | .3036+05 | .4971+00 |
| 100-34 | 29791. | .2232+01 | .4597+04 | .2799-02 | .1748+03 | .1026+05 | .1504+00 |
| 100-35 | 39892. | .4332+01 | .3926+04 | .2041-02 | .2897+03 | .1700+05 | .6621-01 |
| 00-36 | 39892. | .4258+01 | .5682+04 | .4276-02 | .4122+03 | .2419+05 | .9749-01 |
| 00-37 | 39892. | .4240+01 | .4184+04 | .2319-02 | .3022+03 | .1774+05 | .7210-01 |
| 0-38 | 39892. | .4340+01 | .6250+04 | .5174-02 | .4621+03 | .2712+05 | .1052+00 |
| 0-39 | 39892. | .4468+01 | .5579+04 | .4122-02 | .4247+03 | .2493+05 | .9122-01 |
| 0-40 | 49691. | .8237+01 | .2975+04 | .1172-02 | .4174+03 | .2450+05 | .2038-01 |
| -41 | 49691. | .8094+01 | .1573+04 | .3278-03 | .2169+03 | .1273+05 | .1420-01 |
| -42 | 49691. | .8172+01 | .2374+04 | .7465-03 | .3305+03 | .1940+05 | .2122-01 |
| 43 | 49691. | .8068+01 | .3518+04 | .1639-02 | .4836+03 | .2838+05 | .3186-01 |
| 44 | 49691. | .8261+01 | .1916+04 | .4864-03 | .2697+03 | .1583+05 | .1695-01 |
| 5 | 56852. | .1407+02 | .9725+03 | .1253-03 | .2330+03 | .1368+05 | .5051-02 |
| 6 | 56852. | .1343+02 | .1230+04 | .2004-03 | .2815+03 | .1652+05 | .6688-02 |
| | 56852. | .1435+02 | .1831+04 | .4438-03 | .4477+03 | .2628+05 | .9317-02 |
| | 56852. | .1474+02 | .2117+04 | .5934-03 | .5317+03 | .3121+05 | .1049-01 |
| | 56852. | .1385+02 | .2803+04 | .1041-02 | .6613+03 | .3882+05 | .1479-01 |
| | 67179. | .2479+02 | .1230+04 | .2004-03 | .5195+03 | .3049+05 | .3625-02 |

*****************************************************AVERAGED DATA POINTS********

1318-88-1,100F,CAP4,7-13-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .15200+02 |
| .51741+04 | .27252+02 |
| .11365+05 | .46704+02 |
| .19804+05 | .95216+02 |
| .29791+05 | .21336+03 |
| .39892+05 | .43274+03 |
| .49691+05 | .81662+03 |
| .56852+05 | .14089+04 |
| .67194+05 | .24167+04 |
| .78320+05 | .46214+04 |

ALPHA STAR= .94412-04
ALPHA OT= .13520-03

1318-88-1,CAP4,210F,7-15-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .41500+01 |
| .52328+04 | .66891+01 |
| .11686+05 | .10876+02 |
| .23186+05 | .23299+02 |
| .34512+05 | .44981+02 |
| .48446+05 | .94269+02 |
| .70451+05 | .23965+03 |

ALPHA STAR= .73532-04
ALPHA OT= .10372-03

1318-88-1,300F,CAP4,7-15-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .21800+01 |
| .53488+04 | .36045+01 |
| .12072+05 | .57165+01 |
| .23722+05 | .11032+02 |
| .36512+05 | .20891+02 |
| .50122+05 | .35791+02 |
| .66339+05 | .63459+02 |
| .78240+05 | .93191+02 |

ALPHA STAR= .66084-04
ALPHA OT= .11392-03

288469

02

****************************************************************RAW DATA POINTS***

1318-88-1,CAP1,100F,7-16-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11728. | .4223+00 | .1043+06 | .9356+00 | .3536+02 | .4404+05 | .1172+02 |
| 100-2 | 11728. | .4552+00 | .3497+06 | .1052+02 | .1314+03 | .1592+06 | .3645+02 |
| 100-3 | 11728. | .5075+00 | .1840+06 | .2914+01 | .7713+02 | .9341+05 | .1721+02 |
| 100-4 | 11728. | .4433+00 | .5107+06 | .2244+02 | .1870+03 | .2264+06 | .5466+02 |
| 100-5 | 11728. | .3686+00 | .1196+07 | .1231+03 | .3641+03 | .4410+06 | .1540+03 |
| 100-6 | 11728. | .4086+00 | .1081+07 | .1006+03 | .3648+03 | .4418+06 | .1255+03 |
| 100-7 | 11728. | .3940+00 | .1035+07 | .9219+02 | .3368+03 | .4079+06 | .1247+03 |
| 100-8 | 11728. | .4161+00 | .1008+07 | .8738+02 | .3463+03 | .4194+06 | .1149+03 |
| 100-9 | 11728. | .4388+00 | .1004+07 | .8665+02 | .3637+03 | .4404+06 | .1085+03 |
| 100-10 | 11806. | .5016+00 | .2807+06 | .6776+01 | .1163+03 | .1408+06 | .2655+02 |
| 100-11 | 11806. | .4442+00 | .3911+06 | .1316+02 | .1435+03 | .1737+06 | .4177+02 |
| 100-12 | 11806. | .4347+00 | .1553+06 | .2074+01 | .5574+02 | .6751+05 | .1695+02 |
| 100-13 | 11806. | .4897+00 | .1909+06 | .3136+01 | .7721+02 | .9351+05 | .1850+02 |
| 100-14 | 11806. | .4999+00 | .2534+06 | .5968+01 | .1087+03 | .1317+06 | .2500+02 |
| 100-15 | 11806. | .4603+00 | .5543+05 | .6277+00 | .3247+02 | .3932+05 | .8806+01 |
| 100-16 | 11806. | .4512+00 | .9509+05 | .7777+00 | .3543+02 | .4291+05 | .9999+01 |
| 100-17 | 11806. | .4370+00 | .2139+06 | .3937+01 | .8604+02 | .1042+06 | .2084+02 |
| 100-18 | 11806. | .4983+00 | .6746+05 | .3917+00 | .2777+02 | .3363+05 | .6425+01 |
| 100-19 | 11806. | .5089+00 | .1242+06 | .1327+01 | .5220+02 | .6321+05 | .1158+02 |
| 100-20 | 11806. | .3333+00 | .6441+05 | .3569+00 | .1773+02 | .2147+05 | .9169+01 |
| 100-21 | 19691. | .8850+00 | .2065+06 | .3666+01 | .1509+03 | .1827+06 | .1107+02 |
| 100-22 | 19691. | .8841+00 | .2737+06 | .6446+01 | .1999+03 | .2420+06 | .1469+02 |
| 100-23 | 19691. | .9450+00 | .3068+06 | .8098+01 | .2394+03 | .2900+06 | .1541+02 |
| 100-24 | 19691. | .9535+00 | .2224+06 | .4255+01 | .1751+03 | .2121+06 | .1107+02 |
| 100-25 | 19691. | .8702+00 | .4677+06 | .1881+02 | .3360+03 | .4070+06 | .2550+02 |
| 100-26 | 19691. | .8382+00 | .7756+06 | .5175+02 | .5368+03 | .6501+06 | .4391+02 |
| 100-27 | 19691. | .8693+00 | .7608+06 | .5244+02 | .5605+03 | .6788+06 | .4262+02 |
| 100-28 | 19691. | .9211+00 | .6663+06 | .3819+02 | .5068+03 | .6137+06 | .3432+02 |
| 100-29 | 19691. | .8543+00 | .7496+06 | .4633+02 | .5291+03 | .6408+06 | .4161+02 |
| 100-30 | 19691. | .9703+00 | .1229+06 | .1299+01 | .9843+02 | .1192+06 | .6007+01 |
| 100-31 | 19691. | .1019+01 | .5101+05 | .2239+00 | .4294+02 | .5200+05 | .2375+01 |
| 100-32 | 19691. | .9317+00 | .7704+05 | .5106+00 | .5927+02 | .7178+05 | .3924+01 |
| 100-33 | 19691. | .9931+00 | .1780+06 | .2726+01 | .1460+03 | .1768+06 | .8506+01 |
| 100-34 | 19691. | .9561+00 | .2811+06 | .6797+01 | .2224+03 | .2693+06 | .1392+02 |
| 100-35 | 19691. | .9405+00 | .1999+06 | .3437+01 | .1552+03 | .1880+06 | .1008+02 |
| 100-36 | 19691. | .9848+00 | .2566+06 | .5665+01 | .2087+03 | .2527+06 | .1236+02 |
| 100-37 | 19691. | .1020+01 | .2213+05 | .4212+01 | .1864+03 | .2257+06 | .1029+02 |
| 100-38 | 19841. | .9879+00 | .4112+05 | .1455+00 | .3355+02 | .4063+05 | .1975+01 |
| 100-39 | 19841. | .9903+00 | .4685+05 | .1988+00 | .3831+02 | .4639+05 | .2245+01 |
| 100-40 | 19841. | .1016+01 | .7444+05 | .4765+00 | .6246+02 | .7564+05 | .3476+01 |
| 100-41 | 19841. | .1014+01 | .1192+06 | .1222+01 | .9983+02 | .1209+06 | .5577+01 |
| 100-42 | 19841. | .9972+00 | .1359+06 | .1588+01 | .1119+03 | .1355+06 | .6465+01 |

1318--88-2,CAP4,100F,7-26-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1A | 5301. | .5752+02 | .3790+03 | .1924-04 | .3714+03 | .2180+05 | .4867-03 |
| 100-2A | 5301. | .5486+02 | .2980+03 | .1189-04 | .2786+03 | .1635+05 | .4012-03 |
| 100-3A | 5301. | .6164+02 | .3797+03 | .1931-04 | .3987+03 | .2340+05 | .4550-03 |
| 100-1 | 5344. | .5791+02 | .5354+03 | .3838-04 | .5282+03 | .3100+05 | .6829-03 |
| 100-2 | 5344. | .5282+02 | .6711+03 | .6030-04 | .6040+03 | .3545+05 | .9384-03 |
| 100-3 | 5344. | .5499+02 | .4318+03 | .2496-04 | .4045+03 | .2374+05 | .5800-03 |
| 100-4 | 5344. | .5912+02 | .3059+03 | .1253-04 | .3082+03 | .1809+05 | .3822-03 |
| 100-5 | 5344. | .5355+02 | .6711+03 | .6030-04 | .6122+03 | .3594+05 | .9257-03 |
| 100-6 | 11771. | .1046+03 | .2813+03 | .1059-04 | .5014+03 | .2943+05 | .1986-03 |
| 100-7 | 11733. | .9000+02 | .6267+03 | .5259-04 | .9609+03 | .5640+05 | .5143-03 |
| 100-8 | 11733. | .9135+02 | .6513+03 | .5681-04 | .1014+04 | .5950+05 | .5266-03 |
| 100-9 | 11733. | .8759+02 | .6612+03 | .5854-04 | .9867+03 | .5792+05 | .5576-03 |
| 100-9A | 11733. | .1048+03 | .3619+03 | .1753-04 | .6464+03 | .3794+05 | .2549-03 |
| 100-9B | 11733. | .9652+02 | .4678+03 | .2930-04 | .7693+03 | .4515+05 | .3580-03 |
| 100-9C | 11733. | .1022+03 | .3232+03 | .1399-04 | .5628+03 | .3303+05 | .2336-03 |
| 100-9D | 11733. | .9529+02 | .2619+03 | .9185-05 | .4252+03 | .2496+05 | .2030-03 |
| 100-9E | 11733. | .1136+03 | .3938+03 | .2076-04 | .7623+03 | .4474+05 | .2560-03 |
| 100-10 | 11733. | .9574+02 | .4490+03 | .2700-04 | .7324+03 | .4299+05 | .3464-03 |
| 100-11 | 11733. | .9200+02 | .5379+03 | .3874-04 | .8430+03 | .4948+05 | .4318-03 |
| 100-1A | 11890. | .9181+02 | .2682+03 | .9634-05 | .4196+03 | .2463+05 | .2158-03 |
| 100-2A | 11890. | .1060+03 | .1797+03 | .4325-05 | .3247+03 | .1906+05 | .1252-03 |
| 100-3A | 11890. | .1277+03 | .7553+02 | .7638-06 | .1644+03 | .9648+04 | .4367-04 |
| 100-4A | 11890. | .1245+03 | .7553+02 | .7638-06 | .1602+03 | .9404+04 | .4480-04 |
| 100-5A | 11890. | .1139+03 | .8941+02 | .1070-05 | .1735+03 | .1018+05 | .5798-04 |
| 100-6A | 11890. | .1219+03 | .4198+02 | .2360-06 | .8716+02 | .5116+04 | .2544-04 |
| 100-7A | 11890. | .1256+03 | .3725+02 | .1858-06 | .7971+02 | .4679+04 | .2191-04 |
| 100-8A | 11890. | .1234+03 | .3448+02 | .1592-06 | .7248+02 | .4254+04 | .2064-04 |
| 100-1B | 19456. | .2102+03 | .1074+03 | .1544-05 | .3846+03 | .2257+05 | .3773-04 |
| 100-2B | 19456. | .2118+03 | .1353+03 | .2452-05 | .4884+03 | .2867+05 | .4719-04 |
| 100-3B | 19456. | .2093+03 | .1294+03 | .2244-05 | .4615+03 | .2709+05 | .4569-04 |
| 100-12 | 19491. | .2057+03 | .1767+03 | .4182-05 | .6193+03 | .3635+05 | .6346-04 |
| 100-13 | 19417. | .2360+03 | .9151+02 | .1121-05 | .3680+03 | .2160+05 | .2864-04 |
| 100-14 | 19417. | .1687+03 | .1521+03 | .3099-05 | .4372+03 | .2566+05 | .6662-04 |
| 100-15 | 19417. | .2754+03 | .5719+02 | .4380-06 | .2684+03 | .1575+05 | .1534-04 |
| 100-16 | 19417. | .1495+03 | .4187+03 | .2347-04 | .1066+04 | .6258+05 | .2069-03 |
| 100-17 | 19417. | .1810+03 | .3413+03 | .1560-04 | .1053+04 | .6178+05 | .1392-03 |
| 100-18 | 19271. | .1903+03 | .3218+03 | .1387-04 | .1043+04 | .6123+05 | .1249-03 |
| 100-19 | 21908. | .2101+03 | .1819+03 | .4429-05 | .6510+03 | .3821+05 | .6394-04 |
| 100-20 | 22128. | .2699+03 | .1304+03 | .2277-05 | .5995+03 | .3519+05 | .3569-04 |
| 100-21 | 22787. | .2676+03 | .1281+03 | .2198-05 | .5842+03 | .3429+05 | .3536-04 |

1318-88-2,CAP4,210F,7-30-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-1 | 5383. | .1213+02 | .1824+04 | .4189-03 | .3770+03 | .2213+05 | .1044-01 |
| 210-2 | 5363. | .1306+02 | .1613+04 | .3274-03 | .3589+03 | .2107+05 | .8572-02 |
| 210-3 | 5363. | .1311+02 | .9782+03 | .1205-03 | .2184+03 | .1282+05 | .5182-02 |
| 210-4 | 5363. | .1241+02 | .1533+04 | .2960-03 | .3241+03 | .1902+05 | .8583-02 |
| 210-5 | 5363. | .1045+02 | .2750+04 | .9516-03 | .4896+03 | .2874+05 | .1827-01 |
| 210-6 | 5363. | .1090+02 | .3199+04 | .1288-02 | .5939+03 | .3486+05 | .2038-01 |
| 210-7 | 11356. | .1995+02 | .9346+03 | .1099-03 | .3177+03 | .1865+05 | .3252-02 |
| 210-8 | 11356. | .1865+02 | .1336+04 | .2246-03 | .4243+03 | .2491+05 | .4974-02 |
| 210-9 | 11356. | .1994+02 | .1067+04 | .1432-03 | .3623+03 | .2127+05 | .3715-02 |
| 210-10 | 11356. | .1889+02 | .1295+04 | .2113-03 | .4169+03 | .2447+05 | .4762-02 |
| 210-11 | 11356. | .1999+02 | .7429+03 | .6947-04 | .2530+03 | .1465+05 | .2580-02 |
| 210-12 | 19530. | .3199+02 | .9363+03 | .1103-03 | .5103+03 | .2995+05 | .2032-02 |
| 210-21 | 19530. | .3586+02 | .4916+03 | .3041-04 | .3003+03 | .1763+05 | .9516-03 |
| 210-13 | 19677. | .3438+02 | .4584+03 | .2646-04 | .2685+03 | .1576+05 | .9258-03 |
| 210-14 | 19677. | .3589+02 | .5222+03 | .3432-04 | .3193+03 | .1874+05 | .1010-02 |
| 210-15 | 24392. | .4334+02 | .5492+03 | .3796-04 | .4055+03 | .2380+05 | .8798-03 |
| 210-16 | 23950. | .4831+02 | .3604+03 | .1635-04 | .2966+03 | .1741+05 | .5180-03 |
| 210-17 | 23802. | .4325+02 | .5516+03 | .3830-04 | .4065+03 | .2366+05 | .8854-03 |
| 210-18 | 23802. | .4160+02 | .6717+03 | .5680-04 | .4761+03 | .2795+05 | .1121-02 |
| 210-19 | 26675. | .4874+02 | .5295+03 | .3530-04 | .4397+03 | .2581+05 | .7544-03 |
| 210-20 | 26675. | .5641+02 | .3236+03 | .1318-04 | .3110+03 | .1825+05 | .3983-03 |

1318-88-2,CAP4,300F,7-30-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5338. | .4519+01 | .4909+04 | .3227-02 | .3780+03 | .2219+05 | .8024-01 |
| 300-2 | 5338. | .5040+01 | .2416+04 | .7814-03 | .2074+03 | .1217+05 | .3540-01 |
| 300-3 | 5338. | .5365+01 | .1299+04 | .2259-03 | .1187+03 | .6967+04 | .1788-01 |
| 300-4 | 5338. | .4415+01 | .6078+04 | .4947-02 | .4572+03 | .2684+05 | .1017+00 |
| 300-5 | 5338. | .4836+01 | .2286+04 | .6996-03 | .1883+03 | .1105+05 | .3491-01 |
| 300-6 | 5338. | .6407+01 | .5714+04 | .4373-02 | .6237+03 | .3661+05 | .6588-01 |
| 300-7 | 11263. | .6667+01 | .3662+04 | .1796-02 | .4160+03 | .2442+05 | .4058-01 |
| 300-8 | 11263. | .6319+01 | .4688+04 | .2943-02 | .5048+03 | .2963+05 | .5480-01 |
| 300-9 | 11301. | .6402+01 | .3377+04 | .1527-02 | .3683+03 | .2162+05 | .3896-01 |
| 300-10 | 11301. | .6247+01 | .4857+04 | .3159-02 | .5170+03 | .3034+05 | .5743-01 |
| 300-11 | 11301. | .7221+01 | .3766+04 | .1900-02 | .4634+03 | .2720+05 | .3852-01 |
| 300-12 | 20045. | .1099+02 | .2549+04 | .8699-03 | .4774+03 | .2802+05 | .1712-01 |
| 300-13 | 20045. | .1128+02 | .1639+04 | .3595-03 | .3150+03 | .1849+05 | .1073-01 |
| 300-14 | 20045. | .1126+02 | .2419+04 | .7834-03 | .4641+03 | .2724+05 | .1586-01 |
| 300-15 | 20045. | .1189+02 | .1326+04 | .2356-03 | .2687+03 | .1577+05 | .8240-02 |
| 300-16 | 20045. | .1200+02 | .8843+03 | .1047-03 | .1808+03 | .1061+05 | .5443-02 |
| 300-17 | 19942. | .1046+02 | .3901+04 | .2038-02 | .6953+03 | .4081+05 | .2754-01 |
| 300-18 | 25865. | .1498+02 | .1300+04 | .2264-03 | .3318+03 | .1948+05 | .6413-02 |
| 300-19 | 25865. | .1754+02 | .6864+03 | .6310-04 | .2051+03 | .1204+05 | .2891-02 |
| 300-20 | 25865. | .1655+02 | .1221+04 | .1996-03 | .3443+03 | .2021+05 | .5447-02 |
| 300-21 | 26233. | .1871+02 | .7845+03 | .8241-04 | .2501+03 | .1468+05 | .3097-02 |
| 300-22 | 26454. | .1695+02 | .1074+04 | .1544-03 | .3101+03 | .1820+05 | .4679-02 |
| 300-23 | 26896. | .1674+02 | .1113+04 | .1659-03 | .3174+03 | .1863+05 | .4911-02 |
| 300-24 | 27486. | .1796+02 | .1177+04 | .1854-03 | .3602+03 | .2114+05 | .4838-02 |
| 300-25 | 27486. | .1735+02 | .1049+04 | .1474-03 | .3101+03 | .1820+05 | .4467-02 |
| 300-26 | 28193. | .1856+02 | .9267+03 | .1150-03 | .2930+03 | .1720+05 | .3688-02 |
| 300-27 | 28812. | .1814+02 | .1130+04 | .1710-03 | .3492+03 | .2050+05 | .4603-02 |
| 300-28 | 29401. | .1949+02 | .8826+03 | .1043-03 | .2930+03 | .1720+05 | .3345-02 |
| 300-29 | 29990. | .2026+02 | .9591+03 | .1232-03 | .3310+03 | .1943+05 | .3497-02 |
| 300-30 | 30727. | .1977+02 | .1109+04 | .1647-03 | .3736+03 | .2193+05 | .4144-02 |
| 300-31 | 31021. | .2139+02 | .7531+03 | .7595-04 | .2745+03 | .1611+05 | .2600-02 |

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***************************************************AVERAGED DATA POINTS*******

1318--88-2,CAP4,100F,7-26-71

P (PSI)                V (CP)
    .00000          .46900+04
    .53278+04       .56552+04
    .11772+05       .99844+04
    .19779+05       .21048+05

ALPHA STAR AND ALPHA OT MUST BE CALCULATED  BY HAND

1318-88-2,CAP4,210F,7-30-71

P (PSI)                V (CP)
    .00000          .87000+03
    .53666+04       .12008+04
    .11356+05       .19483+04
    .21813+05       .39056+04
    .26675+05       .52574+04

ALPHA STAR=    .69524-04
ALPHA OT=    .53912-04

1318-88-2,CAP4,300F,7-30-71

P (PSI)                V (CP)
    .00000          .37200+03
    .53384+04       .48349+03
    .11286+05       .65713+03
    .20028+05       .11315+04
    .27784+05       .18168+04

ALPHA STAR=    .59671-04
ALPHA OT=    .48579-04
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1318-88-2,CAP1,100F,8-3-71

| RUN | P3 | VISCP | MSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11783. | .8160+02 | .2966+04 | .7147-03 | .1954+03 | .2366+06 | .1671-02 |
| 100-2 | 11783. | .5605+02 | .6945+04 | .4111-02 | .3329+03 | .4032+06 | .5624-02 |
| 100-3 | 11783. | .7328+02 | .3206+04 | .3727-03 | .1936+03 | .2345+06 | .2053-02 |
| 100-4 | 11783. | .5637+02 | .9300+04 | .7371-02 | .4329+03 | .5242+06 | .7755-02 |
| 100-5 | 11783. | .4295+02 | .2375+05 | .4807-01 | .8423+03 | .1020+07 | .2600-01 |
| 100-6 | 11783. | .3885+02 | .3200+05 | .8727-01 | .1026+04 | .1243+07 | .3873-01 |
| 100-7 | 11783. | .4024+02 | .3700+05 | .1167+00 | .1229+04 | .1489+07 | .4323-01 |
| 100-8 | 11783. | .4092+02 | .3112+05 | .8256-01 | .1052+04 | .1274+07 | .3576-01 |
| 100-9 | 11783. | .5526+02 | .1060+05 | .8525-02 | .4563+03 | .5526+06 | .8509-02 |
| 100-10 | 11783. | .5498+02 | .1178+05 | .1182-01 | .5346+03 | .6475+06 | .1097-01 |
| 100-11 | 11783. | .4999+02 | .1549+05 | .2044-01 | .6392+03 | .7741+06 | .1456-01 |
| 100-12 | 11783. | .4569+02 | .2013+05 | .3454-01 | .7596+03 | .9199+06 | .2071-01 |
| 100-13 | 11783. | .7811+02 | .1761+04 | .2643-03 | .1136+03 | .1375+06 | .1060-02 |
| 100-14 | 11783. | .6348+02 | .5018+04 | .2146-02 | .2630+03 | .3185+06 | .3715-02 |
| 100-15 | 11783. | .7574+02 | .3351+04 | .9572-03 | .2124+03 | .2572+06 | .2053-02 |
| 100-16 | 11783. | .7748+02 | .1666+04 | .2366-03 | .1066+03 | .1291+06 | .1011-02 |
| 100-17 | 11783. | .9269+02 | .7856+03 | .5262-04 | .6014+02 | .7283+05 | .3985-03 |
| 100-18 | 11783. | .8763+02 | .1136+04 | .1100-03 | .8221+02 | .9955+05 | .6094-03 |
| 100-19 | 11783. | .7403+02 | .1638+04 | .2286-03 | .1001+03 | .1213+06 | .1040-02 |
| 100-20 | 11783. | .9449+02 | .4355+03 | .1616-04 | .3398+02 | .4115+05 | .2167-03 |
| 100-21 | 11783. | .9563+02 | .5728+03 | .2796-04 | .4494+02 | .5443+05 | .2833-03 |
| 100-22 | 11783. | .1068+03 | .2177+03 | .4038-05 | .1919+02 | .2324+05 | .9586-04 |
| 100-23 | 11783. | .1105+03 | .1610+03 | .2210-05 | .1470+02 | .1730+05 | .6850-04 |
| 100-23A | 11783. | .1120+03 | .2421+03 | .4995-05 | .2240+02 | .2712+05 | .1016-03 |
| 100-23B | 11783. | .1624+03 | .3154+03 | .8478-05 | .2566+02 | .3229+05 | .1440-03 |
| 100-23C | 11783. | .1388+03 | .6130+02 | .3203-06 | .7025+01 | .8507+04 | .2077-04 |
| 100-24 | 19088. | .1218+03 | .3230+04 | .8892-03 | .3247+03 | .3933+06 | .1247-02 |
| 100-25 | 19088. | .1268+03 | .2659+04 | .6024-03 | .2784+03 | .3372+06 | .9855-03 |
| 100-26 | 18943. | .7705+02 | .1554+05 | .2059-01 | .9888+03 | .1197+07 | .9482-02 |
| 100-27 | 18943. | .8211+02 | .1477+05 | .1858-01 | .1001+04 | .1212+07 | .8454-02 |
| 100-28 | 18943. | .6477+02 | .1277+05 | .1398-01 | .8939+03 | .1083+07 | .7082-02 |
| 100-29 | 18943. | .7830+02 | .1772+05 | .2676-01 | .1146+04 | .1387+07 | .1064-01 |
| 100-30 | 18943. | .1414+03 | .1935+04 | .3190-03 | .2266+03 | .2744+06 | .6412-03 |
| 100-31 | 18943. | .1678+03 | .6464+03 | .3561-04 | .8934+02 | .1082+06 | .1816-03 |
| 100-32 | 18943. | .1477+03 | .1518+04 | .1963-03 | .1852+03 | .2242+06 | .4829-03 |
| 100-33 | 18943. | .1697+03 | .3953+03 | .1332-04 | .5538+02 | .6707+05 | .1096-03 |
| 100-34 | 18793. | .1370+03 | .2361+04 | .4750-03 | .2688+03 | .3255+06 | .8050-03 |
| 100-35 | 18793. | .1572+03 | .7260+03 | .4493-04 | .1002+03 | .1214+06 | .2042-03 |
| 100-36 | 18793. | .1608+03 | .1065+04 | .8612-04 | .1335+03 | .1617+06 | .2938-03 |
| 100-37 | 18793. | .1715+03 | .5059+03 | .2181-04 | .7163+02 | .8675+05 | .1387-03 |
| 100-38 | 18793. | .1695+03 | .7120+03 | .4326-04 | .9966+02 | .1207+06 | .1975-03 |
| 100-39 | 18793. | .1570+03 | .1087+04 | .1006-03 | .1409+03 | .1706+06 | .3254-03 |
| 100-40 | 18793. | .1994+03 | .2068+03 | .3716-05 | .3445+02 | .4172+05 | .4913-04 |
| 100-41 | 18793. | .2062+03 | .7615+02 | .4929-06 | .1368+02 | .1584+05 | .1717-04 |
| 100-42 | 18793. | .2155+03 | .1714+03 | .2505-05 | .3051+02 | .3695+05 | .3740-04 |
| 100-43 | 18793. | .2090+03 | .9451+02 | .7613-06 | .1631+02 | .1976+05 | .2125-04 |
| 100-44 | 18793. | .2160+03 | .1637+03 | .2285-05 | .2839+02 | .3439+05 | .3666-04 |

FLUID 1318-88-3,100F,CAP4,4 28 71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 3-1-100 | 5389. | .9275+00 | .2381+05 | .7592-01 | .3763+03 | .2208+05 | .1896+01 |
| 3-2-100 | 5389. | .9414+00 | .1323+05 | .2343-01 | .2122+03 | .1245+05 | .1038+01 |
| 3-4-100 | 5389. | .9115+00 | .1984+05 | .5272-01 | .3081+03 | .1809+05 | .1608+01 |
| 3-5-100 | 5389. | .8818+00 | .2183+05 | .6379-01 | .3279+03 | .1925+05 | .1828+01 |
| 3-6-100 | 5389. | .1035+01 | .3175+05 | .1350+00 | .5600+03 | .3287+05 | .2265+01 |
| 3-7-100 | 11412. | .1678+01 | .7386+04 | .7304-02 | .2111+03 | .1239+05 | .3252+00 |
| 3-8-100 | 11412. | .1723+01 | .9039+04 | .1094-01 | .2653+03 | .1557+05 | .3876+00 |
| 3-9-100 | 11412. | .1645+01 | .9921+04 | .1318-01 | .2780+03 | .1632+05 | .4456+00 |
| 3-10-100 | 11412. | .1523+01 | .1598+05 | .3421-01 | .4147+03 | .2434+05 | .7752+00 |
| 3-11-100 | 11490. | .1536+01 | .4442+05 | .2643+00 | .1163+04 | .6824+05 | .2136+01 |
| 3-12-100 | 11530. | .1688+01 | .1213+05 | .1969-01 | .3487+03 | .2046+05 | .5307+00 |
| 3-13-100 | 11373. | .1644+01 | .1742+05 | .4062-01 | .4880+03 | .2864+05 | .7823+00 |
| 3-15-100 | 11608. | .1745+01 | .2712+05 | .9847-01 | .8060+03 | .4731+05 | .1148+01 |
| 3-16-100 | 19927. | .3302+01 | .2426+04 | .7879-03 | .1365+03 | .8010+04 | .5426-01 |
| 3-17-100 | 20079. | .3563+01 | .7996+04 | .8562-02 | .4853+03 | .2849+05 | .1658+00 |
| 3-19-100 | 19927. | .3348+01 | .1543+05 | .3187-01 | .8800+03 | .5165+05 | .3403+00 |
| 3-20-100 | 19927. | .3444+01 | .1737+05 | .4041-01 | .1019+04 | .5983+05 | .3726+00 |
| 3-22-100 | 20079. | .3467+01 | .8435+04 | .9527-02 | .4983+03 | .2925+05 | .1797+00 |
| 3-23-100 | 20079. | .3438+01 | .1192+05 | .1901-01 | .6979+03 | .4097+05 | .2560+00 |
| 3-24-100 | 20079. | .3604+01 | .6177+04 | .5110-02 | .3793+03 | .2226+05 | .1266+00 |
| 3-25-100 | 20384. | .4042+01 | .8592+04 | .9885-02 | .5916+03 | .3473+05 | .1570+00 |
| 3-26-100 | 20232. | .3641+01 | .8560+04 | .9813-02 | .5311+03 | .3117+05 | .1736+00 |
| 3-27-100 | 29536. | .7412+01 | .1881+04 | .4740-03 | .2376+03 | .1395+05 | .1875-01 |
| 3-28-100 | 29689. | .7232+01 | .1129+04 | .1706-03 | .1391+03 | .8164+04 | .1153-01 |
| 3-29-100 | 29536. | .7566+01 | .5080+04 | .3455-02 | .6548+03 | .3843+05 | .4959-01 |
| 3-30-100 | 29689. | .7547+01 | .2223+04 | .6615-03 | .2858+03 | .1677+05 | .2175-01 |
| 3-31-100 | 29689. | .7274+01 | .6060+04 | .4917-02 | .7510+03 | .4408+05 | .6153-01 |
| 3-32-100 | 29536. | .7600+01 | .3125+04 | .1308-02 | .4047+03 | .2375+05 | .3037-01 |
| 3-33-100 | 39908. | .1566+02 | .2379+04 | .7577-03 | .6347+03 | .3726+05 | .1122-01 |
| 3-34-100 | 39908. | .1471+02 | .2796+04 | .1046-02 | .7005+03 | .4112+05 | .1404-01 |
| 3-35-100 | 39756. | .1653+02 | .2865+04 | .1099-02 | .8068+03 | .4736+05 | .1280-01 |
| 3-36-100 | 40061. | .1559+02 | .1667+04 | .3721-03 | .4426+03 | .2598+05 | .7899-02 |
| 3-37-100 | 40061. | .1629+02 | .2032+04 | .5527-03 | .5639+03 | .3310+05 | .9210-02 |
| 3-1-100 | 51195. | .3213+02 | .1962+04 | .5155-03 | .1074+04 | .6304+05 | .4511-02 |
| 3-2-100 | 51348. | .2876+02 | .9203+03 | .1134-03 | .4509+03 | .2647+05 | .2363-02 |
| 3-3-100 | 51348. | .2884+02 | .2396+04 | .7688-03 | .1177+04 | .6910+05 | .6138-02 |
| 3-4-100 | 51348. | .3206+02 | .1597+04 | .3417-03 | .8726+03 | .5122+05 | .3680-02 |
| 3-6-100 | 62025. | .7033+02 | .3994+03 | .2136-04 | .4785+03 | .2809+05 | .4194-03 |
| 3-7-100 | 62025. | .6378+02 | .7690+03 | .7918-04 | .8355+03 | .4904+05 | .8906-03 |
| 3-10-100 | 61873. | .5506+02 | .4599+03 | .2832-04 | .4314+03 | .2532+05 | .6170-03 |
| 3-11-100 | 72855. | .1327+03 | .3107+03 | .1292-04 | .7021+03 | .4121+05 | .1730-03 |
| 3-12-100 | 73160. | .1330+03 | .2193+03 | .6440-05 | .4970+03 | .2917+05 | .1218-03 |
| 3-13-100 | 73160. | .1297+03 | .2589+03 | .8975-05 | .5721+03 | .3358+05 | .1474-03 |
| 3-14-100 | 73312. | .1355+03 | .2437+03 | .7950-05 | .5627+03 | .3303+05 | .1328-03 |
| 3-15-100 | 73160. | .1161+03 | .2680+03 | .9620-05 | .5302+03 | .3112+05 | .1705-03 |
| 3-16-100 | 80329. | .1852+03 | .8003+02 | .8577-06 | .2525+03 | .1482+05 | .3193-04 |
| 3-17-100 | 80329. | .2179+03 | .1229+03 | .2023-05 | .4563+03 | .2678+05 | .4166-04 |
| 3-18-100 | 79871. | .2090+03 | .1358+03 | .2468-05 | .4835+03 | .2838+05 | .4798-04 |
| 3-19-100 | 80329. | .1959+03 | .1315+03 | .2315-05 | .4389+03 | .2576+05 | .4956-04 |
| 3-20-100 | 80024. | .2000+03 | .1229+03 | .2023-05 | .4188+03 | .2458+05 | .4540-04 |

FLUID 1318 883,210F,CAP4,MAY2 1971

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 32101 | 5389. | .2041+00 | .3088+05 | .1230+00 | .1074+03 | .6302+04 | .1077+02 |
| 32102 | 5389. | .2496+00 | .4516+05 | .2632+00 | .1920+03 | .1127+05 | .1288+02 |
| 32103 | 5428. | .2527+00 | .4463+05 | .2570+00 | .1921+03 | .1128+05 | .1257+02 |
| 32104 | 5389. | .2245+00 | .8041+05 | .8343+00 | .3076+03 | .1805+05 | .2549+02 |
| 32105 | 5428. | .2432+00 | .7759+05 | .7769+00 | .3215+03 | .1887+05 | .2271+02 |
| 32107 | 5389. | .2303+00 | .5327+05 | .3662+00 | .2090+03 | .1227+05 | .1646+02 |
| 32108 | 5428. | .2142+00 | .7505+05 | .7268+00 | .2739+03 | .1608+05 | .2494+02 |
| 32109 | 5428. | .2410+00 | .4885+05 | .3079+00 | .2005+03 | .1177+05 | .1443+02 |
| 321012 | 11686. | .3795+00 | .2694+05 | .9363-01 | .1742+03 | .1022+05 | .5052+01 |
| 321013 | 11725. | .3431+00 | .3672+05 | .1740+00 | .2147+03 | .1260+05 | .7617+01 |
| 321014 | 11764. | .3771+00 | .3618+05 | .1689+00 | .2324+03 | .1364+05 | .6830+01 |
| 321015 | 11764. | .3713+00 | .3994+05 | .2058+00 | .2526+03 | .1483+05 | .7657+01 |
| 321016 | 11725. | .4250+00 | .2965+05 | .1134+00 | .2147+03 | .1260+05 | .4966+01 |
| 321017 | 11725. | .4424+00 | .3752+05 | .1817+00 | .2828+03 | .1660+05 | .6037+01 |
| 321018 | 11725. | .3710+00 | .3913+05 | .1976+00 | .2474+03 | .1452+05 | .7507+01 |
| 321019 | 11764. | .3764+00 | .3860+05 | .1922+00 | .2475+03 | .1453+05 | .7298+01 |
| 321020 | 11764. | .3733+00 | .3377+05 | .1472+00 | .2148+03 | .1261+05 | .6439+01 |
| 321021 | 11803. | .3788+00 | .3793+05 | .1856+00 | .2447+03 | .1437+05 | .7127+01 |
| 321022 | 11725. | .3985+00 | .4610+05 | .2742+00 | .3130+03 | .1837+05 | .8234+01 |
| 321023 | 19907. | .5794+00 | .1501+05 | .2907-01 | .1481+03 | .8695+04 | .1844+01 |
| 321024 | 19907. | .7036+00 | .2185+05 | .6158-01 | .2619+03 | .1537+05 | .2210+01 |
| 321025 | 20205. | .6278+00 | .1477+05 | .2816-01 | .1580+03 | .9274+04 | .1675+01 |
| 321026 | 20205. | .6910+00 | .2790+05 | .1004+00 | .3284+03 | .1928+05 | .2873+01 |
| 321027 | 20503. | .6851+00 | .3045+05 | .1196+00 | .3554+03 | .2086+05 | .3163+01 |
| 321028 | 19758. | .5941+00 | .2145+05 | .5938-01 | .2171+03 | .1275+05 | .2570+01 |
| 321029 | 19907. | .5578+00 | .1611+05 | .3348-01 | .1531+03 | .8986+04 | .2055+01 |
| 321030 | 19758. | .5989+00 | .1524+05 | .2999-01 | .1555+03 | .9129+04 | .1812+01 |
| 321031 | 19758. | .6805+00 | .1257+05 | .2040-01 | .1458+03 | .8555+04 | .1315+01 |
| 321032 | 19758. | .6343+00 | .2240+05 | .6472-01 | .2420+03 | .1421+05 | .2513+01 |
| 321033 | 49116. | .3099+01 | .1046+05 | .1411-01 | .5522+03 | .3241+05 | .2402+00 |
| 321034 | 48967. | .3053+01 | .6472+04 | .5404-02 | .3366+03 | .1976+05 | .1509+00 |
| 321035 | 48967. | .2991+01 | .1105+05 | .1575-01 | .5631+03 | .3305+05 | .2629+00 |
| 321036 | 49563. | .3358+01 | .6603+04 | .5626-02 | .3778+03 | .2218+05 | .1399+00 |
| 321037 | 49712. | .3198+01 | .4562+04 | .2685-02 | .2485+03 | .1459+05 | .1015+00 |
| 321038 | 49563. | .3260+01 | .5272+04 | .3586-02 | .2928+03 | .1719+05 | .1151+00 |
| 321039 | 69831. | .8225+01 | .4183+04 | .2258-02 | .5862+03 | .3441+05 | .3620-01 |
| 321040 | 69681. | .9532+01 | .2115+04 | .5773-03 | .3435+03 | .2016+05 | .1579-01 |
| 321041 | 69831. | .7978+01 | .1752+04 | .3961-03 | .2381+03 | .1398+05 | .1563-01 |
| 321042 | 69831. | .7171+01 | .1949+04 | .4902-03 | .2381+03 | .1398+05 | .1935-01 |
| 321043 | 69831. | .8050+01 | .1736+04 | .3890-03 | .2381+03 | .1398+05 | .1535-01 |
| 321044 | 69831. | .7368+01 | .1897+04 | .4644-03 | .2381+03 | .1398+05 | .1833-01 |
| 321045 | 69980. | .7951+01 | .1705+04 | .3750-03 | .2309+03 | .1355+05 | .1526-01 |
| 321046 | 69980. | .7498+01 | .1808+04 | .4217-03 | .2309+03 | .1355+05 | .1716-01 |

E1318-88-3,CAP4,300F,5-3-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 3-1-300 | 5340. | .1134+00 | .1208+06 | .1814+01 | .2332+03 | .1369+05 | .7310+02 |
| 3-2-300 | 5359. | .1180+00 | .1295+06 | .2086+01 | .2604+03 | .1528+05 | .7530+02 |
| 3-3-300 | 5359. | .1464+00 | .7627+05 | .7237+00 | .1902+03 | .1116+05 | .3576+02 |
| 3-4-300 | 5320. | .1055+00 | .5958+05 | .4417+00 | .1071+03 | .6285+04 | .3876+02 |
| 3-5-300 | 5359. | .1063+00 | .6999+05 | .6095+00 | .1268+03 | .7442+04 | .4517+02 |
| 3-6-300 | 5398. | .1025+00 | .7964+05 | .7892+00 | .1390+03 | .8161+04 | .5334+02 |
| 3-7-300 | 5359. | .1066+00 | .8254+05 | .8477+00 | .1499+03 | .8799+04 | .5314+02 |
| 3-8-300 | 5320. | .1036+00 | .9851+05 | .1207+01 | .1739+03 | .1021+05 | .6523+02 |
| 3-9-300 | 5340. | .9952-01 | .1057+06 | .1389+01 | .1792+03 | .1052+05 | .7286+02 |
| 3-10-300 | 5340. | .1186+00 | .1073+06 | .1431+01 | .2167+03 | .1272+05 | .6206+02 |
| 3-11-300 | 11890. | .1681+00 | .6554+05 | .5345+00 | .1878+03 | .1102+05 | .2675+02 |
| 3-12-300 | 11928. | .1844+00 | .6225+05 | .4820+00 | .1955+03 | .1148+05 | .2317+02 |
| 3-13-300 | 11851. | .1808+00 | .4727+05 | .2780+00 | .1456+03 | .8547+04 | .1794+02 |
| 3-14-300 | 11696. | .1723+00 | .5700+05 | .4042+00 | .1673+03 | .9821+04 | .2270+02 |
| 3-15-300 | 11696. | .1761+00 | .4131+05 | .2123+00 | .1239+03 | .7275+04 | .1610+02 |
| 3-16-300 | 11716. | .1738+00 | .4330+05 | .2332+00 | .1282+03 | .7527+04 | .1709+02 |
| 3-17-300 | 11696. | .1730+00 | .7269+05 | .6574+00 | .2142+03 | .1258+05 | .2884+02 |
| 3-18-300 | 11696. | .1658+00 | .3694+05 | .1698+00 | .1044+03 | .6126+04 | .1529+02 |
| 3-19-300 | 20652. | .3022+00 | .4157+05 | .2150+00 | .2140+03 | .1256+05 | .9440+01 |
| 3-20-300 | 20503. | .3395+00 | .3654+05 | .1661+00 | .2113+03 | .1240+05 | .7387+01 |
| 3-21-300 | 20623. | .3160+00 | .3575+05 | .1590+00 | .1925+03 | .1130+05 | .7764+01 |
| 3-22-300 | 20503. | .3016+00 | .5029+05 | .3147+00 | .2584+03 | .1517+05 | .1144+02 |
| 3-23-300 | 20652. | .3197+00 | .4440+05 | .2452+00 | .2418+03 | .1419+05 | .9531+01 |
| 3-24-300 | 20474. | .2583+00 | .4086+05 | .2077+00 | .1798+03 | .1055+05 | .1086+02 |
| 3-25-300 | 20354. | .3086+00 | .3253+05 | .1317+00 | .1710+03 | .1004+05 | .7235+01 |
| 3-26-300 | 20265. | .2771+00 | .2860+05 | .1018+00 | .1351+03 | .7927+04 | .7083+01 |
| 3-27-300 | 20354. | .2873+00 | .4400+05 | .2409+00 | .2154+03 | .1264+05 | .1051+02 |
| 3-28-300 | 20354. | .2910+00 | .2691+05 | .9012-01 | .1334+03 | .7831+04 | .6348+01 |
| 3-29-300 | 35406. | .6428+00 | .1925+05 | .4611-01 | .2108+03 | .1238+05 | .2055+01 |
| 3-30-300 | 35182. | .6929+00 | .2141+05 | .5704-01 | .2528+03 | .1464+05 | .2121+01 |
| 3-31-300 | 34959. | .6002+00 | .1906+05 | .4518-01 | .1949+03 | .1144+05 | .2179+01 |
| 3-32-300 | 34959. | .6103+00 | .1572+05 | .3073-01 | .1634+03 | .9591+04 | .1767+01 |
| 3-33-300 | 34959. | .6204+00 | .2102+05 | .5497-01 | .2222+03 | .1304+05 | .2325+01 |
| 3-34-300 | 19982. | .6010+00 | .2078+05 | .5374-01 | .2128+03 | .1249+05 | .2373+01 |
| 3-35-300 | 52186. | .1160+01 | .6929+04 | .5974-02 | .1370+03 | .8040+04 | .4098+00 |
| 3-36-300 | 52246. | .1241+01 | .7394+04 | .6802-02 | .1563+03 | .9175+04 | .4089+00 |
| 3-37-300 | 52097. | .1196+01 | .1124+05 | .1572-01 | .2290+03 | .1344+05 | .6449+00 |
| 3-38-300 | 51650. | .1109+01 | .8789+04 | .9610-02 | .1660+03 | .9744+04 | .5440+00 |
| 3-39-300 | 51620. | .1145+01 | .6253+04 | .4865-02 | .1220+03 | .7160+04 | .3748+00 |
| 3-40-300 | 51650. | .1169+01 | .4901+04 | .2989-02 | .9763+02 | .5730+04 | .2877+00 |
| 3-41-300 | 51650. | .1214+01 | .9887+04 | .1216-01 | .2045+03 | .1200+05 | .5589+00 |
| 3-42-300 | 51530. | .1224+01 | .1318+05 | .2162-01 | .2750+03 | .1614+05 | .7390+00 |
| 3-43-300 | 51530. | .1207+01 | .1115+05 | .1548-01 | .2294+03 | .1346+05 | .6343+00 |
| 3-44-300 | 51545. | .1197+01 | .1673+05 | .3483-01 | .3412+03 | .2002+05 | .9595+00 |
| 3-45-300 | 51515. | .1141+01 | .4901+04 | .2989-02 | .9527+02 | .5592+04 | .2948+00 |
| 3-46-300 | 51515. | .1122+01 | .1020+05 | .1295-01 | .1950+03 | .1145+05 | .6242+00 |
| 3-47-300 | 51501. | .1143+01 | .7014+04 | .6121-02 | .1366+03 | .8019+04 | .4210+00 |
| 3-48-300 | 71485. | .2381+01 | .7087+04 | .6249-02 | .2875+03 | .1687+05 | .2043+00 |
| 3-49-300 | 71351. | .2384+01 | .6203+04 | .4787-02 | .2520+03 | .1479+05 | .1785+00 |
| 3-50-300 | 71395. | .2489+01 | .8576+04 | .9150-02 | .3636+03 | .2134+05 | .2365+00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3-51-300 | 71991. | .2387+01 | .7945+04 | .7853-02 | .3230+03 | .1896+05 | .2284+00 |
| 3-52-300 | 71842. | .2480+01 | .6840+04 | .5820-02 | .2890+03 | .1697+05 | .1892+00 |
| 3-53-300 | 71321. | .2826+01 | .4104+04 | .2095-02 | .1976+03 | .1160+05 | .9964-01 |
| 3-54-300 | 71321. | .2430+01 | .6835+04 | .5811-02 | .2829+03 | .1661+05 | .1930+00 |
| 3-55-300 | 71321. | .2438+01 | .5630+04 | .3943-02 | .2338+03 | .1372+05 | .1585+00 |
| 3-56-300 | 71172. | .2560+01 | .7261+04 | .6559-02 | .3167+03 | .1859+05 | .1946+00 |
| 3-57-300 | 71172. | .2516+01 | .7156+04 | .6370-02 | .3067+03 | .1800+05 | .1952+00 |
| 3-58-300 | 80188. | .3505+01 | .3788+04 | .1785-02 | .2262+03 | .1328+05 | .7417-01 |
| 3-59-300 | 79964. | .3378+01 | .4199+04 | .2193-02 | .2416+03 | .1418+05 | .8529-01 |
| 3-60-300 | 79964. | .3337+01 | .2494+04 | .7738-03 | .1418+03 | .8321+04 | .5129-01 |
| 3-61-300 | 79964. | .3537+01 | .4209+04 | .2204-02 | .2536+03 | .1489+05 | .8168-01 |
| 3-62-300 | 79815. | .3469+01 | .2522+04 | .7915-03 | .1491+03 | .8750+04 | .4990-01 |
| 3-63-300 | 79815. | .3548+01 | .3125+04 | .1215-02 | .1889+03 | .1109+05 | .6044-01 |
| 3-64-300 | 79815. | .3515+01 | .3662+04 | .1668-02 | .2193+03 | .1287+05 | .7149-01 |
| 3-65-300 | 79815. | .3423+01 | .6393+04 | .5084-02 | .3728+03 | .2188+05 | .1282+00 |
| 3-66-300 | 79815. | .3430+01 | .4735+04 | .2790-02 | .2768+03 | .1624+05 | .9473-01 |

*******************************************AVERAGED DATA POINTS******

FLUID 1318-88-3,100F,CAP4,4 28 71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .55000+02 |
| .53892+04 | .93954+02 |
| .11456+05 | .16476+03 |
| .20079+05 | .35387+03 |
| .29612+05 | .74387+03 |
| .39939+05 | .15756+04 |
| .51310+05 | .30448+04 |
| .61974+05 | .63054+04 |
| .73129+05 | .12941+05 |
| .80176+05 | .20161+05 |

ALPHA STAR= .91109-04
ALPHA OT= .10789-03

FLUID 1318 883,210F,CAP4,MAY2 1971

| P (PSI) | V (CP) |
|---|---|
| .00000 | .13400+02 |
| .54088+04 | .23244+02 |
| .11743+05 | .38513+02 |
| .19967+05 | .63525+02 |
| .49315+05 | .31600+03 |
| .69873+05 | .77487+03 |

ALPHA STAR= .77195-04
ALPHA OT= .12050-03

E1318-88-3,CAP4,300F,5-3-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .67200+01 |
| .53483+04 | .10823+02 |
| .11771+05 | .17430+02 |
| .20474+05 | .30012+02 |
| .35093+05 | .63332+02 |
| .51710+05 | .11745+03 |
| .71437+05 | .24891+03 |
| .79906+05 | .34602+03 |

ALPHA STAR= .67489-04
ALPHA OT= .10096-03

288475

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*****************************************************************RAW DATA POINTS***

1318-88-3,100F,CAP1,5-17-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 3-100-1 | 11497. | .1563+01 | .1575+06 | .2157+01 | .2033+03 | .2462+06 | .4832+01 |
| 3-100-2 | 11419. | .1479+01 | .1743+06 | .2642+01 | .2129+03 | .2578+06 | .5654+01 |
| 3-100-3 | 11497. | .1933+01 | .2798+06 | .6909+01 | .4465+03 | .5408+06 | .6945+01 |
| 3-100-4 | 11419. | .1650+01 | .1973+06 | .3394+01 | .2688+03 | .3255+06 | .5734+01 |
| 3-100-5 | 11419. | .1950+01 | .2000+06 | .3479+01 | .3220+03 | .3900+06 | .4920+01 |
| 3-100-6 | 11497. | .1581+01 | .2083+06 | .3772+01 | .2718+03 | .3292+06 | .6320+01 |
| 3-100-7 | 11497. | .6728+00 | .4205+06 | .1538+02 | .2336+03 | .2829+06 | .2998+02 |
| 3-100-8 | 11497. | .1505+01 | .2431+06 | .5140+01 | .3224+03 | .3904+06 | .7263+01 |
| 3-100-9 | 11769. | .1649+01 | .4128+06 | .1482+02 | .5620+03 | .6807+06 | .1201+02 |
| 3-100-10 | 11652. | .1884+01 | .2624+06 | .5987+01 | .4082+03 | .4943+06 | .5681+01 |
| 3-100-11 | 11652. | .1402+01 | .3211+06 | .8967+01 | .3717+03 | .4501+06 | .1099+02 |
| 3-100-12 | 11730. | .1501+01 | .3119+06 | .8462+01 | .4124+03 | .4994+06 | .9346+01 |
| 3-100-13 | 11652. | .1560+01 | .2982+06 | .7732+01 | .3840+03 | .4651+06 | .9170+01 |
| 3-100-14 | 20294. | .3960+01 | .4745+05 | .1958+00 | .1552+03 | .1879+06 | .5748+00 |
| 3-100-15 | 20445. | .3544+01 | .1219+06 | .1292+01 | .3668+03 | .4442+06 | .1604+01 |
| 3-100-16 | 20294. | .3368+01 | .1615+06 | .2269+01 | .4492+03 | .5440+06 | .2300+01 |
| 3-100-17 | 20445. | .3204+01 | .1642+06 | .2346+01 | .4346+03 | .5263+06 | .2459+01 |
| 3-100-18 | 20445. | .3538+01 | .1414+06 | .1740+01 | .4132+03 | .5004+06 | .1918+01 |
| 3-100-19 | 20445. | .3590+01 | .8760+05 | .6673+00 | .2597+03 | .3145+06 | .1171+01 |
| 3-100-20 | 20595. | .3333+01 | .1469+06 | .1877+01 | .4044+03 | .4897+06 | .2114+01 |
| 3-100-21 | 20746. | .3629+01 | .1378+06 | .1651+01 | .4129+03 | .5000+06 | .1821+01 |
| 3-100-22 | 20745. | .3782+01 | .1168+06 | .1186+01 | .3648+03 | .4418+06 | .1481+01 |
| 3-100-23 | 20897. | .3564+01 | .1141+06 | .1131+01 | .3451+03 | .4179+06 | .1493+01 |
| 3-100-24 | 20746. | .3380+01 | .2035+06 | .3601+01 | .5679+03 | .6877+06 | .2888+01 |
| 3-100-25 | 20897. | .2440+01 | .1323+06 | .1522+01 | .2666+03 | .3229+06 | .2601+01 |

288503

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1318-88-4,100F,CAP4,5-31-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5328. | .6917+01 | .4214+04 | .2434-02 | .4965+03 | .2914+05 | .4606-01 |
| 100-2 | 5328. | .7227+01 | .5691+04 | .4440-02 | .7008+03 | .4113+05 | .5954-01 |
| 100-3 | 5328. | .7172+01 | .3019+04 | .1249-02 | .3688+03 | .2165+05 | .3182-01 |
| 100-4 | 5325. | .7557+01 | .5597+04 | .4294-02 | .7206+03 | .4230+05 | .5600-01 |
| 100-9 | 5367. | .7201+01 | .4140+04 | .2350-02 | .5079+03 | .2981+05 | .4347-01 |
| 100-10 | 5367. | .7276+01 | .5974+04 | .4893-02 | .7406+03 | .4347+05 | .6209-01 |
| 100-5 | 11330. | .1219+02 | .2124+04 | .6185-03 | .4410+03 | .2588+05 | .1316-01 |
| 100-6 | 11330. | .1256+02 | .2890+04 | .1145-02 | .6184+03 | .3630+05 | .1740-01 |
| 100-7 | 11291. | .1306+02 | .2995+04 | .1229-02 | .6666+03 | .3913+05 | .1733-01 |
| 100-11 | 11330. | .1275+02 | .1611+04 | .3556-03 | .3497+03 | .2053+05 | .9554-02 |
| 100-12 | 11339. | .1345+02 | .2046+04 | .5737-03 | .4689+03 | .2752+05 | .1150-01 |
| 100-13 | 11330. | .1263+02 | .3134+04 | .1346-02 | .6742+03 | .3957+05 | .1877-01 |
| 100-14 | 11291. | .1241+02 | .4723+04 | .3058-02 | .9987+03 | .5862+05 | .2877-01 |
| 100-15 | 11232. | .1237+02 | .3874+04 | .2057-02 | .8162+03 | .4791+05 | .2369-01 |
| 100-16 | 16554. | .2534+02 | .5223+03 | .9270-04 | .3691+03 | .2166+05 | .2360-02 |
| 100-17 | 18705. | .2401+02 | .9512+03 | .1242-03 | .3893+03 | .2285+05 | .2997-02 |
| 100-18 | 18706. | .2369+02 | .9899+03 | .1343-03 | .3994+03 | .2345+05 | .3160-02 |
| 100-19 | 18706. | .2486+02 | .2369+04 | .7696-03 | .1004+04 | .5891+05 | .7206-02 |
| 100-20 | 18706. | .2493+02 | .2316+04 | .7350-03 | .9835+03 | .5773+05 | .7023-02 |
| 100-21 | 16554. | .2487+02 | .2369+04 | .7696-03 | .1004+04 | .5892+05 | .7205-02 |
| 100-22 | 16554. | .2572+02 | .1939+04 | .5152-03 | .8496+03 | .4987+05 | .5699-02 |
| 100-23 | 29384. | .5991+02 | .4873+03 | .3255-04 | .4974+03 | .2919+05 | .5150-03 |
| 100-24 | 29078. | .5936+02 | .5025+03 | .3462-04 | .5083+03 | .2983+05 | .5401-03 |
| 100-25 | 29334. | .5879+02 | .4772+03 | .3121-04 | .4779+03 | .2805+05 | .5137-03 |
| 100-26 | 29231. | .5691+02 | .5685+03 | .4431-04 | .5512+03 | .3236+05 | .7553-03 |
| 100-27 | 29307. | .5944+02 | .4914+03 | .3310-04 | .4976+03 | .2921+05 | .6250-03 |
| 100-28 | 41691. | .1380+03 | .3376+03 | .1563-04 | .7939+03 | .4660+05 | .1850-03 |
| 100-29 | 41691. | .1302+03 | .3591+03 | .1767-04 | .7966+03 | .4675+05 | .2085-03 |
| 100-30 | 41891. | .1360+03 | .3930+03 | .2117-04 | .9103+03 | .5343+05 | .2186-03 |
| 100-31 | 41691. | .1295+03 | .3519+03 | .1698-04 | .7763+03 | .4557+05 | .2055-03 |
| 100-32 | 41691. | .1341+03 | .3752+03 | .1929-04 | .8571+03 | .5031+05 | .2115-03 |
| 100-33 | 52253. | .2773+03 | .1358+03 | .2527-05 | .6414+03 | .3765+05 | .3702-04 |
| 100-34 | 52187. | .2555+03 | .1285+03 | .2268-05 | .5567+03 | .3326+05 | .3761-04 |
| 100-35 | 52253. | .2559+03 | .1274+03 | .2226-05 | .5555+03 | .3261+05 | .3766-04 |
| 100-36 | 52253. | .2724+03 | .1941+03 | .5166-05 | .9009+03 | .5288+05 | .5389-04 |
| 100-37 | 52253. | .2723+03 | .2025+03 | .5619-05 | .9409+03 | .5523+05 | .5612-04 |
| 100-38 | 52155. | .2581+03 | .2299+03 | .7242-05 | .1011+04 | .5932+05 | .6734-04 |
| 100-39 | 64084. | .5761+03 | .6610+02 | .5989-06 | .6420+03 | .3768+05 | .9766-05 |
| 100-40 | 63932. | .5774+03 | .9111+02 | .1138-05 | .8963+03 | .5261+05 | .1193-04 |
| 100-41 | 63932. | .6132+03 | .1054+03 | .1523-05 | .1101+04 | .6463+05 | .1300-04 |
| 100-42 | 63932. | .4895+03 | .1242+03 | .2113-05 | .1036+04 | .6078+05 | .1918-04 |
| 100-43 | 73312. | .8816+03 | .5610+02 | .5989-06 | .9928+03 | .5827+05 | .5669-05 |
| 100-44 | 73160. | .8555+03 | .6878+02 | .6484-06 | .1002+04 | .5884+05 | .6079-05 |
| 100-45 | 73160. | .9491+03 | .6610+02 | .5989-06 | .1069+04 | .6273+05 | .5266-05 |
| 100-46 | 73160. | .9212+03 | .7235+02 | .7175-06 | .1135+04 | .6665+05 | .5939-05 |

1318-88-4,210F,CAP4,6-12-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-37 | 5376. | .1511+01 | .7426+04 | .7210-02 | .1912+03 | .1122+05 | .3543+00 |
| 210-38 | 5376. | .1505+01 | .1822+05 | .4342-01 | .4671+03 | .2742+05 | .8734+00 |
| 210-39 | 5376. | .1543+01 | .1902+05 | .4732-01 | .4999+03 | .2934+05 | .8894+00 |
| 210-40 | 5375. | .1522+01 | .2190+05 | .6272-01 | .5680+03 | .3334+05 | .1030+01 |
| 210-41 | 5376. | .1479+01 | .1322+05 | .2284-01 | .3331+03 | .1955+05 | .6442+00 |
| 210-42 | 5376. | .1615+01 | .2570+05 | .8635-01 | .7070+03 | .4150+05 | .1148+01 |
| 210-31 | 12207. | .2535+01 | .1282+05 | .2147-01 | .5535+03 | .3249+05 | .3646+00 |
| 210-32 | 12207. | .2560+01 | .7796+04 | .7945-02 | .3560+03 | .2089+05 | .2098+00 |
| 210-33 | 12169. | .2562+01 | .8940+04 | .1045-01 | .3902+03 | .2290+05 | .2517+00 |
| 210-34 | 12169. | .2520+01 | .1011+05 | .1337-01 | .4341+03 | .2548+05 | .2894+00 |
| 210-35 | 12131. | .2549+01 | .5674+04 | .4209-02 | .2464+03 | .1446+05 | .1605+00 |
| 210-36 | 12131. | .2623+01 | .1168+05 | .1784-01 | .5220+03 | .3064+05 | .3212+00 |
| 210-1 | 21491. | .4854+01 | .5169+04 | .3662-02 | .4274+03 | .2509+05 | .8052-01 |
| 210-2 | 21491. | .4620+01 | .5369+04 | .3952-02 | .4226+03 | .2481+05 | .8788-01 |
| 210-3 | 21346. | .4945+01 | .5246+04 | .3772-02 | .4419+03 | .2594+05 | .8022-01 |
| 210-4 | 21346. | .4700+01 | .5670+04 | .4407-02 | .4541+03 | .2665+05 | .9122-01 |
| 210-5 | 21346. | .4597+01 | .6079+04 | .5066-02 | .5072+03 | .2977+05 | .9387-01 |
| 210-6 | 21491. | .5038+01 | .3827+04 | .2007-02 | .3285+03 | .1928+05 | .5742-01 |
| 210-7 | 36933. | .1130+02 | .2007+04 | .5522-03 | .3865+03 | .2269+05 | .1343-01 |
| 210-8 | 36787. | .1146+02 | .1745+04 | .4175-03 | .3406+03 | .1999+05 | .1152-01 |
| 210-9 | 36642. | .1114+02 | .2075+04 | .5902-03 | .3937+03 | .2311+05 | .1409-01 |
| 210-10 | 37079. | .1067+02 | .2473+04 | .8380-03 | .4493+03 | .2637+05 | .1753-01 |
| 210-11 | 37079. | .1139+02 | .2240+04 | .6877-03 | .4348+03 | .2552+05 | .1486-01 |
| 210-12 | 36787. | .1105+02 | .2909+04 | .1150-02 | .5483+03 | .3218+05 | .1988-01 |
| 210-13 | 51209. | .2231+02 | .9454+03 | .1225-03 | .3594+03 | .2109+05 | .3203-02 |
| 210-14 | 51209. | .2262+02 | .1164+04 | .1856-03 | .4524+03 | .2655+05 | .3855-02 |
| 210-15 | 50919. | .2255+02 | .1425+04 | .2785-03 | .5477+03 | .3215+05 | .4778-02 |
| 210-16 | 51063. | .2372+02 | .5890+03 | .4756-04 | .2381+03 | .1397+05 | .1877-02 |
| 210-17 | 51063. | .1969+02 | .1193+04 | .1950-03 | .4000+03 | .2348+05 | .4580-02 |
| 210-18 | 51063. | .2190+02 | .1920+04 | .5052-03 | .7191+03 | .4221+05 | .6602-02 |
| 210-19 | 67233. | .4664+02 | .7738+03 | .8206-04 | .6148+03 | .3609+05 | .1254-02 |
| 210-20 | 67233. | .4492+02 | .7418+03 | .7542-04 | .5677+03 | .3332+05 | .1248-02 |
| 210-21 | 67088. | .4626+02 | .7054+03 | .6820-04 | .5560+03 | .3263+05 | .1153-02 |
| 210-22 | 67088. | .4504+02 | .8727+03 | .1044-03 | .6695+03 | .3930+05 | .1465-02 |
| 210-23 | 67233. | .4520+02 | .7418+03 | .7542-04 | .5723+03 | .3359+05 | .1238-02 |
| 210-24 | 67233. | .4515+02 | .5963+03 | .4874-04 | .4587+03 | .2692+05 | .9986-03 |
| 210-25 | 77431. | .7132+02 | .4322+03 | .2560-04 | .5251+03 | .3082+05 | .4582-03 |
| 210-26 | 77285. | .7272+02 | .5236+03 | .3758-04 | .6487+03 | .3808+05 | .5444-03 |
| 210-27 | 76994. | .7427+02 | .3236+03 | .1435-04 | .4095+03 | .2403+05 | .3294-03 |
| 210-28 | 76994. | .7166+02 | .6749+03 | .6243-04 | .8239+03 | .4836+05 | .7120-03 |
| 210-29 | 76994. | .6834+02 | .5876+03 | .4733-04 | .6842+03 | .4016+05 | .6501-03 |
| 210-30 | 77431. | .6915+02 | .2369+03 | .7690-05 | .2791+03 | .1638+05 | .2590-03 |

1318-88-4,300F,CAP4,6-12-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5193. | .6774+00 | .1504+05 | .2848-01 | .1736+03 | .1019+05 | .1542+01 |
| 300-2 | 5230. | .7156+00 | .2360+05 | .7013-01 | .2877+03 | .1689+05 | .2290+01 |
| 300-3 | 5265. | .6061+00 | .2314+05 | .6740-01 | .2389+03 | .1402+05 | .2651+01 |
| 300-4 | 5230. | .7120+00 | .2571+05 | .8322-01 | .3123+03 | .1833+05 | .2504+01 |
| 300-5 | 5263. | .7234+00 | .1653+05 | .3439-01 | .2037+03 | .1196+05 | .1586+01 |
| 300-6 | 5263. | .7121+00 | .2507+05 | .7911-01 | .3041+03 | .1785+05 | .2444+01 |
| 300-7 | 10895. | .1095+01 | .1466+05 | .2704-01 | .2741+03 | .1609+05 | .9271+00 |
| 300-8 | 10933. | .1096+01 | .2700+05 | .9174-01 | .5042+03 | .2959+05 | .1710+01 |
| 300-9 | 10896. | .1120+01 | .2160+05 | .5872-01 | .4121+03 | .2419+05 | .1339+01 |
| 300-10 | 10971. | .1107+01 | .1967+05 | .4870-01 | .3709+03 | .2177+05 | .1234+01 |
| 300-11 | 10933. | .1035+01 | .1358+05 | .2320-01 | .2400+03 | .1409+05 | .9083+00 |
| 300-12 | 10933. | .1079+01 | .1820+05 | .4171-01 | .3347+03 | .1965+05 | .1171+01 |
| 300-13 | 21346. | .2005+01 | .1357+05 | .2318-01 | .4635+03 | .2721+05 | .4700+00 |
| 300-14 | 21346. | .2057+01 | .1178+05 | .1746-01 | .4128+03 | .2423+05 | .3976+00 |
| 300-15 | 21200. | .1953+01 | .1045+05 | .1374-01 | .3476+03 | .2040+05 | .3714+00 |
| 300-16 | 21200. | .1929+01 | .1050+05 | .1387-01 | .3451+03 | .2026+05 | .3778+00 |
| 300-17 | 21054. | .1826+01 | .1490+05 | .2795-01 | .4636+03 | .2721+05 | .5667+00 |
| 300-18 | 21054. | .1668+01 | .1972+05 | .4893-01 | .5602+03 | .3288+05 | .8208+00 |
| 300-20 | 36737. | .3654+01 | .6939+04 | .6061-02 | .4320+03 | .2536+05 | .1318+00 |
| 300-21 | 36737. | .3716+01 | .6403+04 | .5161-02 | .4054+03 | .2380+05 | .1196+00 |
| 300-22 | 36737. | .3552+01 | .6288+04 | .4976-02 | .4127+03 | .2422+05 | .1133+00 |
| 300-23 | 36685. | .3968+01 | .5285+04 | .3515-02 | .3573+03 | .2097+05 | .9246-01 |
| 300-24 | 36685. | .3911+01 | .5979+04 | .4500-02 | .3983+03 | .2338+05 | .1062+00 |
| 300-25 | 51792. | .7755+01 | .2417+04 | .7355-03 | .3194+03 | .1875+05 | .2164-01 |
| 300-26 | 51792. | .7579+01 | .2327+04 | .6816-03 | .3005+03 | .1764+05 | .2132-01 |
| 300-27 | 51646. | .7145+01 | .3389+04 | .1446-02 | .4125+03 | .2421+05 | .3293-01 |
| 300-28 | 51282. | .7304+01 | .3986+04 | .2000-02 | .4960+03 | .2911+05 | .3789-01 |
| 300-29 | 51355. | .7500+01 | .4217+04 | .2239-02 | .5389+03 | .3163+05 | .3904-01 |
| 300-30 | 51355. | .7344+01 | .4706+04 | .2788-02 | .5888+03 | .3456+05 | .4449-01 |
| 300-31 | 72769. | .1583+02 | .1377+04 | .2386-03 | .3713+03 | .2179+05 | .6040-02 |
| 300-32 | 72473. | .1551+02 | .2516+04 | .7969-03 | .6651+03 | .3904+05 | .1126-01 |
| 300-33 | 72623. | .1551+02 | .2516+04 | .7969-03 | .6651+03 | .3904+05 | .1126-01 |
| 300-34 | 72473. | .1464+02 | .2211+04 | .6152-03 | .5514+03 | .3237+05 | .1048-01 |
| 300-35 | 72473. | .1410+02 | .1910+04 | .4593-03 | .4615+03 | .2709+05 | .9352-02 |
| 300-36 | 78742. | .1385+02 | .7156+03 | .6445-04 | .2299+03 | .1349+05 | .2635-02 |
| 300-37 | 78451. | .1330+02 | .1200+04 | .1812-03 | .3740+03 | .2195+05 | .4553-02 |
| 300-38 | 78305. | .1789+02 | .1113+04 | .1555-03 | .3392+03 | .1991+05 | .4317-02 |
| 300-39 | 78305. | .1826+02 | .1120+04 | .1579-03 | .3485+03 | .2045+05 | .4257-02 |
| 300-40 | 78159. | .1770+02 | .1156+04 | .1683-03 | .3487+03 | .2046+05 | .4536-02 |
| 300-41 | 78159. | .1803+02 | .1316+04 | .2181-03 | .4044+03 | .2374+05 | .5068-02 |

***************************************************AVERAGED DATA POINTS**********

1318-88-4,100F,C P4,5-31-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .43300+03 |
| .53413+04 | .72243+03 |
| .11308+05 | .12673+04 |
| .18641+05 | .24917+04 |
| .29277+05 | .58883+04 |
| .41891+05 | .13359+05 |
| .52233+05 | .26534+05 |
| .63970+05 | .56257+05 |
| .73198+05 | .90193+05 |

ALPHA STAR= .90297-04
ALPHA OT= .10112-03

1318-88-4,210F,C P4,6-12-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .85000+02 |
| .53762+04 | .15292+03 |
| .12169+05 | .25781+03 |
| .21418+05 | .45422+03 |
| .36884+05 | .11170+04 |
| .51088+05 | .22181+04 |
| .67185+05 | .45550+04 |
| .77188+05 | .71244+04 |

ALPHA STAR= .79249-04
ALPHA OT= .13233-03

1318-88-4,300F,C P4,6-12-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .43000+02 |
| .52428+04 | .69124+02 |
| .10927+05 | .10896+03 |
| .21200+05 | .19063+03 |
| .36746+05 | .38203+03 |
| .51537+05 | .74381+03 |
| .72565+05 | .15136+04 |
| .78353+05 | .18173+04 |

ALPHA STAR= .65467-04
ALPHA OT= .99814-04

288451

*************************************************************RAW DATA POINTS***

1318-88-4,100F,CAP1

| RUN | P3 | VISCP | VSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11301. | .1014+02 | .3228+05 | .9279-01 | .2704+03 | .3274+06 | .1563+00 |
| 100-2 | 11301. | .2144+02 | .1804+05 | .2896-01 | .3194+03 | .3868+06 | .4130-01 |
| 100-3 | 11301. | .2252+02 | .8129+04 | .5883-02 | .1531+03 | .1855+06 | .1750-01 |
| 100-4 | 11301. | .2156+02 | .2155+05 | .4249-01 | .3889+03 | .4710+06 | .4976-01 |
| 100-5 | 11301. | .1053+02 | .3892+05 | .1341+00 | .3375+03 | .4088+06 | .1810+00 |
| 100-6 | 11377. | .8079+01 | .1150+06 | .1178+01 | .7673+03 | .9292+06 | .6991+00 |
| 100-7 | 11377. | .9668+01 | .9027+05 | .7254+00 | .7207+03 | .8727+06 | .4585+00 |
| 100-8 | 11377. | .9852+01 | .7571+05 | .5103+00 | .6159+03 | .7459+06 | .3773+00 |
| 100-9 | 11301. | .1104+02 | .9512+05 | .8055+00 | .8673+03 | .1050+07 | .4230+00 |
| 100-10 | 11301. | .1163+02 | .1097+06 | .1071+01 | .9631+03 | .1166+07 | .5065+00 |
| 100-11 | 11301. | .8529+01 | .1291+06 | .1484+01 | .9090+03 | .1101+07 | .7434+00 |
| 100-12 | 11301. | .1050+02 | .5169+05 | .2378+00 | .4519+03 | .5472+06 | .2397+00 |
| 100-13 | 11339. | .1074+02 | .3858+05 | .1325+00 | .3422+03 | .4144+06 | .1764+00 |
| 100-14 | 11339. | .9792+01 | .6625+05 | .3907+00 | .5356+03 | .6487+06 | .3322+00 |
| 100-15 | 20334. | .3410+02 | .1691+05 | .2546-01 | .4761+03 | .5766+06 | .2435-01 |
| 100-16 | 20414. | .2569+02 | .4192+05 | .1564+00 | .8868+03 | .1076+07 | .8016-01 |
| 100-17 | 20414. | .2020+02 | .3968+05 | .1402+00 | .6618+03 | .8015+06 | .9646-01 |
| 100-18 | 20414. | .1953+02 | .4904+05 | .2141+00 | .7948+03 | .9626+06 | .1227+00 |
| 100-19 | 20340. | .2149+02 | .2767+05 | .6818-01 | .4908+03 | .5944+06 | .6327-01 |
| 100-20 | 20340. | .2004+02 | .4212+05 | .1580+00 | .6971+03 | .8442+06 | .1032+00 |
| 100-21 | 20340. | .1944+02 | .5474+05 | .2657+00 | .8785+03 | .1064+07 | .1382+00 |
| 100-22 | 20929. | .7433+01 | .2198+05 | .4300-01 | .1349+03 | .1633+06 | .1452+00 |
| 100-23 | 20855. | .2577+02 | .1250+05 | .1391-01 | .2560+03 | .3221+06 | .2382-01 |
| 100-24 | 20855. | .2649+02 | .5613+04 | .2805-02 | .1228+03 | .1487+06 | .1041-01 |
| 100-25 | 20856. | .2526+02 | .1345+05 | .1612-01 | .2807+03 | .3399+06 | .2615-01 |
| 100-26 | 20856. | .2372+02 | .2112+05 | .3972-01 | .4661+03 | .5644+06 | .3882-01 |
| 100-27 | 20856. | .2625+02 | .6275+04 | .6096-02 | .1794+03 | .2173+06 | .1548-01 |
| 100-28 | 20856. | .2407+02 | .1866+05 | .3101-01 | .3710+03 | .4493+06 | .3807-01 |

288517



1318-88-6,100F,CAP4,6-19-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5319. | .2211+02 | .1393+04 | .2579-03 | .5248+03 | .3080+05 | .4619-02 |
| 100-2 | 5330. | .2153+02 | .2221+04 | .6556-03 | .8147+03 | .4782+05 | .7563-02 |
| 100-3 | 5330. | .2293+02 | .2549+04 | .8640-03 | .9983+03 | .5860+05 | .8133-02 |
| 100-4 | 5330. | .2159+02 | .1708+04 | .3880-03 | .6283+03 | .3688+05 | .5803-02 |
| 100-5 | 5330. | .2230+02 | .2234+04 | .6634-03 | .8489+03 | .4983+05 | .7344-02 |
| 100-6 | 5330. | .2292+02 | .2549+04 | .8640-03 | .9955+03 | .5843+05 | .8156-02 |
| 100-7 | 11584. | .3745+02 | .7685+03 | .7855-04 | .4909+03 | .2881+05 | .1504-02 |
| 100-8 | 11592. | .3912+02 | .9439+03 | .1184-03 | .6290+03 | .3692+05 | .1769-02 |
| 100-9 | 11592. | .3799+02 | .1189+04 | .1880-03 | .7697+03 | .4518+05 | .2295-02 |
| 100-10 | 11592. | .3721+02 | .7432+03 | .7343-04 | .4712+03 | .2766+05 | .1465-02 |
| 100-11 | 11592. | .3897+02 | .1420+04 | .2679-03 | .9424+03 | .5531+05 | .2671-02 |
| 100-12 | 11592. | .4015+02 | .1367+04 | .2483-03 | .9350+03 | .5488+05 | .2496-02 |
| 100-13 | 11592. | .3904+02 | .1393+04 | .2579-03 | .9264+03 | .5438+05 | .2617-02 |
| 100-14 | 11592. | .3928+02 | .9659+03 | .1240-03 | .6464+03 | .3794+05 | .1803-02 |
| 100-15 | 20856. | .9457+02 | .2574+03 | .3809-05 | .4147+03 | .2434+05 | .1996-03 |
| 100-16 | 20856. | .8922+02 | .3567+03 | .1691-04 | .5422+03 | .3183+05 | .2932-03 |
| 100-17 | 20855. | .8795+02 | .3696+03 | .1816-04 | .5538+03 | .3251+05 | .3081-03 |
| 100-18 | 20708. | .9090+02 | .4462+03 | .2645-04 | .6910+03 | .4056+05 | .3599-03 |
| 100-19 | 20708. | .8789+02 | .6693+03 | .5955-04 | .1002+04 | .5882+05 | .5584-03 |
| 100-20 | 20708. | .8921+02 | .3775+03 | .1895-04 | .5739+03 | .3368+05 | .3103-03 |
| 100-21 | 20708. | .8834+02 | .5001+03 | .3325-04 | .7570+03 | .4443+05 | .4128-03 |
| 100-22 | 30580. | .2035+03 | .1324+03 | .2330-05 | .4590+03 | .2694+05 | .4770-04 |
| 100-23 | 30580. | .1944+03 | .1545+03 | .3171-05 | .5116+03 | .3003+05 | .5826-04 |
| 100-24 | 30533. | .1906+03 | .3052+03 | .1239-04 | .9912+03 | .5818+05 | .1174-03 |
| 100-25 | 30583. | .1966+03 | .2096+03 | .5841-05 | .7020+03 | .4121+05 | .7818-04 |
| 100-26 | 30533. | .1949+03 | .2537+03 | .8559-05 | .8424+03 | .4945+05 | .9547-04 |
| 100-27 | 30727. | .1928+03 | .2465+03 | .3094-05 | .8107+03 | .4759+05 | .9382-04 |
| 100-28 | 30583. | .1877+03 | .3192+03 | .1355-04 | .1021+04 | .5991+05 | .1247-03 |
| 100-29 | 41629. | .4003+03 | .7161+02 | .6817-06 | .4884+03 | .2867+05 | .1312-04 |
| 100-30 | 41629. | .3321+03 | .1553+03 | .3206-05 | .1011+04 | .5935+05 | .2980-04 |
| 100-31 | 41600. | .4199+03 | .1369+03 | .2491-05 | .9793+03 | .5748+05 | .2390-04 |
| 100-32 | 41482. | .4127+03 | .1145+03 | .1742-05 | .8047+03 | .4723+05 | .2034-04 |
| 100-33 | 41482. | .4109+03 | .1231+03 | .2014-05 | .8616+03 | .5057+05 | .2197-04 |
| 100-34 | 41482. | .3915+03 | .1219+03 | .1977-05 | .8133+03 | .4774+05 | .2234-04 |
| 100-35 | 52093. | .8579+03 | .7075+02 | .6654-06 | .1034+04 | .6070+05 | .6047-05 |
| 100-36 | 51643. | .7713+03 | .7922+02 | .3134-06 | .1028+04 | .6033+05 | .7437-05 |
| 100-37 | 51795. | .7157+03 | .7937+02 | .8375-06 | .9679+03 | .5681+05 | .8132-05 |
| 100-38 | 51648. | .7846+03 | .7132+02 | .6762-06 | .9534+03 | .5596+05 | .6665-05 |
| 100-39 | 51643. | .7273+03 | .7132+02 | .6762-06 | .8337+03 | .5187+05 | .7191-05 |
| 100-40 | 51501. | .7635+03 | .6672+02 | .5919-06 | .8579+03 | .5094+05 | .6408-05 |

2

1318-88-6,210F,CAP4,6-18-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-1 | 5363. | .3619+01 | .3280+04 | .1373-02 | .2023+03 | .1167+05 | .6379-01 |
| 210-2 | 5353. | .3744+01 | .6794+04 | .5889-02 | .4334+03 | .2544+05 | .1277+00 |
| 210-3 | 5353. | .3767+01 | .4416+04 | .2488-02 | .2834+03 | .1664+05 | .8250-01 |
| 210-4 | 5353. | .3300+01 | .7898+04 | .7959-02 | .5113+03 | .3001+05 | .1463+00 |
| 210-5 | 5363. | .3824+01 | .5053+04 | .3258-02 | .3293+03 | .1933+05 | .9298-01 |
| 210-6 | 5363. | .3772+01 | .1756+05 | .3943-01 | .1130+04 | .6632+05 | .3280+00 |
| 210-7 | 11644. | .6700+01 | .4459+04 | .2536-02 | .5090+03 | .2988+05 | .4683-01 |
| 210-8 | 11644. | .6687+01 | .4836+04 | .2986-02 | .5512+03 | .3236+05 | .5091-01 |
| 210-9 | 11644. | .6210+01 | .2300+04 | .6750-03 | .2434+03 | .1428+05 | .2607-01 |
| 210-10 | 11644. | .6523+01 | .4580+04 | .2677-02 | .5090+03 | .2988+05 | .4942-01 |
| 210-11 | 11625. | .6029+01 | .1013+05 | .1309-01 | .1040+04 | .6106+05 | .1182+00 |
| 210-12 | 11625. | .6424+01 | .3652+04 | .1701-02 | .3997+03 | .2346+05 | .4001-01 |
| 210-13 | 11625. | .5907+01 | .5945+04 | .4509-02 | .5982+03 | .3511+05 | .7083-01 |
| 210-14 | 21994. | .1195+02 | .4577+04 | .2673-02 | .9323+03 | .5472+05 | .2695-01 |
| 210-15 | 21994. | .1199+02 | .2486+04 | .7885-03 | .5079+03 | .2981+05 | .1459-01 |
| 210-16 | 21994. | .1163+02 | .1894+04 | .4577-03 | .3754+03 | .2204+05 | .1146-01 |
| 210-17 | 21994. | .1223+02 | .2407+04 | .7392-03 | .5014+03 | .2943+05 | .1386-01 |
| 210-18 | 21994. | .1167+02 | .1236+04 | .1950-03 | .2458+03 | .1443+05 | .7458-02 |
| 210-19 | 21994. | .1129+02 | .4775+04 | .2909-02 | .9187+03 | .5392+05 | .2975-01 |
| 210-20 | 37641. | .2350+02 | .9002+03 | .1034-03 | .4371+03 | .2566+05 | .2222-02 |
| 210-21 | 37641. | .2955+02 | .6853+03 | .9998-04 | .4458+03 | .2616+05 | .2108-02 |
| 210-22 | 37641. | .2901+02 | .5695+03 | .5719-04 | .3309+03 | .1942+05 | .1624-02 |
| 210-23 | 37641. | .2919+02 | .1525+04 | .2967-03 | .7581+03 | .4450+05 | .3678-02 |
| 210-24 | 37641. | .2369+02 | .1723+04 | .3798-03 | .8420+03 | .4942+05 | .4228-02 |
| 210-25 | 37641. | .3006+02 | .1763+04 | .3963-03 | .9025+03 | .5298+05 | .4126-02 |
| 210-25 | 52991. | .6111+02 | .3916+03 | .1958-04 | .4079+03 | .2394+05 | .4512-03 |
| 210-27 | 52991. | .6293+02 | .4364+03 | .2430-04 | .4680+03 | .2747+05 | .4880-03 |
| 210-28 | 52991. | .5912+02 | .4364+03 | .2430-04 | .4396+03 | .2580+05 | .5195-03 |
| 210-29 | 52991. | .5839+02 | .2529+03 | .8162-05 | .2516+03 | .1477+05 | .3049-03 |
| 210-30 | 52991. | .5765+02 | .6778+03 | .9831-04 | .8621+03 | .5060+05 | .1072-02 |
| 210-31 | 52991. | .5818+02 | .6555+03 | .9338-04 | .8480+03 | .4977+05 | .1035-02 |
| 210-32 | 68737. | .1180+03 | .1850+03 | .4367-05 | .3719+03 | .2182+05 | .1104-03 |
| 210-33 | 68639. | .1166+03 | .2286+03 | .6669-05 | .4542+03 | .2666+05 | .1380-03 |
| 210-34 | 68439. | .1104+03 | .3962+03 | .2003-04 | .7453+03 | .4375+05 | .2525-03 |
| 210-35 | 68439. | .1120+03 | .4922+03 | .3091-04 | .9395+03 | .5514+05 | .3091-03 |
| 210-36 | 68439. | .1121+03 | .3945+03 | .1985-04 | .7532+03 | .4421+05 | .2477-03 |

①2

1318-88-6,300F,CAP4,6-18-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5325. | .1954+01 | .9181+04 | .1044-01 | .3057+03 | .1794+05 | .3211+00 |
| 300-2 | 5325. | .1952+01 | .1395+05 | .2412-01 | .4640+03 | .2724+05 | .4885+00 |
| 300-3 | 5325. | .2149+01 | .1092+05 | .1479-01 | .3999+03 | .2347+05 | .3476+00 |
| 300-4 | 5325. | .1979+01 | .1343+05 | .2234-01 | .4527+03 | .2657+05 | .4637+00 |
| 300-5 | 5325. | .1943+01 | .2744+05 | .9333-01 | .9086+03 | .5333+05 | .9653+00 |
| 300-6 | 5325. | .1915+01 | .2231+05 | .6168-01 | .7281+03 | .4273+05 | .7962+00 |
| 300-7 | 11682. | .3181+01 | .6819+04 | .9637-02 | .4779+03 | .2805+05 | .1895+00 |
| 300-8 | 11663. | .3514+01 | .6055+04 | .4543-02 | .3624+03 | .2127+05 | .1178+00 |
| 300-9 | 11855. | .3609+01 | .6055+04 | .4543-02 | .3723+03 | .2185+05 | .1147+00 |
| 300-10 | 11655. | .3522+01 | .5791+04 | .4156-02 | .3475+03 | .2040+05 | .1124+00 |
| 300-11 | 11855. | .3585+01 | .6581+04 | .5367-02 | .4020+03 | .2359+05 | .1255+00 |
| 300-12 | 11778. | .2963+01 | .7371+04 | .6733-02 | .3721+03 | .2184+05 | .1700+00 |
| 300-13 | 20561. | .5266+01 | .2475+04 | .7591-03 | .2221+03 | .1304+05 | .3212-01 |
| 300-14 | 20561. | .5260+01 | .4323+04 | .2316-02 | .3881+03 | .2278+05 | .5609-01 |
| 300-15 | 20561. | .5162+01 | .2193+04 | .5960-03 | .1929+03 | .1132+05 | .2904-01 |
| 300-16 | 20561. | .5321+01 | .2289+04 | .6491-03 | .2075+03 | .1218+05 | .2940-01 |
| 300-17 | 20561. | .5206+01 | .4955+04 | .3042-02 | .4394+03 | .2579+05 | .6506-01 |
| 300-18 | 20561. | .5340+01 | .1691+04 | .3542-03 | .1538+03 | .9027+04 | .2164-01 |
| 300-19 | 20561. | .5127+01 | .4877+04 | .2947-02 | .4260+03 | .2500+05 | .6501-01 |
| 300-20 | 20561. | .5275+01 | .2445+04 | .7407-03 | .2197+03 | .1290+05 | .3168-01 |
| 300-21 | 35441. | .1111+02 | .1412+04 | .2472-03 | .2674+03 | .1569+05 | .9687-02 |
| 300-22 | 35441. | .1256+02 | .2601+04 | .8383-03 | .4811+03 | .2824+05 | .1637-01 |
| 300-23 | 35368. | .1133+02 | .2081+04 | .5365-03 | .4017+03 | .2358+05 | .1255-01 |
| 300-24 | 35368. | .1133+02 | .1300+04 | .2096-03 | .2510+03 | .1474+05 | .7845-02 |
| 300-25 | 35368. | .1090+02 | .2393+04 | .7095-03 | .4445+03 | .2609+05 | .1500-01 |
| 300-26 | 35368. | .9944+01 | .1196+04 | .1774-03 | .2027+03 | .1190+05 | .8224-02 |
| 300-27 | 51574. | .2051+02 | .9267+03 | .1064-03 | .3238+03 | .1901+05 | .3089-02 |
| 300-28 | 51574. | .2175+02 | .1008+04 | .1258-03 | .3734+03 | .2192+05 | .3167-02 |
| 300-29 | 51645. | .2117+02 | .7943+03 | .7819-04 | .2864+03 | .1681+05 | .2565-02 |
| 300-30 | 51501. | .2259+02 | .5864+03 | .4290-04 | .2263+03 | .1329+05 | .1781-02 |
| 300-31 | 51645. | .1924+02 | .1613+04 | .3222-03 | .5286+03 | .3103+05 | .5729-02 |
| 300-32 | 51645. | .2257+02 | .8563+03 | .9129-04 | .3301+03 | .1937+05 | .2599-02 |
| 300-33 | 69622. | .4004+02 | .4560+03 | .2577-04 | .3110+03 | .1826+05 | .7786-03 |
| 300-34 | 69475. | .4267+02 | .4658+03 | .2689-04 | .3402+03 | .1997+05 | .7428-03 |
| 300-35 | 69325. | .3969+02 | .7649+03 | .7250-04 | .5172+03 | .3036+05 | .1317-02 |
| 300-36 | 69254. | .3679+02 | .5541+03 | .3804-04 | .3662+03 | .2149+05 | .9763-03 |
| 300-37 | 69254. | .3937+02 | .8334+03 | .5712-04 | .5624+03 | .3301+05 | .1456-02 |
| 300-38 | 69180. | .3913+02 | .7723+03 | .7390-04 | .5149+03 | .3022+05 | .1349-02 |

******************************************************AVERAGED DATA POINTS**********

1318-88-6,100F,C P4,6-19-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .13100+04 |
| .53263+04 | .22242+04 |
| .11591+05 | .39655+04 |
| .20771+05 | .[illegible]9799+04 |
| .30601+05 | .10430+05 |
| .41551+05 | .41290+05 |
| .51722+05 | .77005+05 |

ALPHA STAR= .91364-04
ALPHA DT= .11021-03

1318-88-6,210F,C P4,6-18-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .25830+03 |
| .53634+04 | .37544+03 |
| .11636+05 | .63542+03 |
| .21994+05 | .11794+04 |
| .37641+05 | .23165+04 |
| .52991+05 | .59563+04 |
| .63579+05 | .11391+05 |

ALPHA STAR= .60675-04
ALPHA DT= .56419-04

1318-88-6,300F,C P4,6-18-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .11800+03 |
| .53250+04 | .19822+03 |
| .11781+05 | .33955+03 |
| .23561+05 | .52400+03 |
| .35392+05 | .10917+04 |
| .51599+05 | .21313+04 |
| .69352+05 | .39982+04 |

ALPHA STAR= .69161-04
ALPHA DT= .10967-03

1318-88-6,100F,CAP1,6-29-71

| RUN | P3 | VISCP | WSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11575. | .3420+02 | .8094+04 | .5655-02 | .2287+03 | .2770+06 | .1126-01 |
| 100-2 | 11575. | .2876+02 | .1451+05 | .1817-01 | .3443+03 | .4169+06 | .2404-01 |
| 100-3 | 11575. | .2826+02 | .1960+05 | .3316-01 | .4573+03 | .5538+06 | .3302-01 |
| 100-4 | 11575. | .2342+02 | .2474+05 | .5284-01 | .5805+03 | .7031+06 | .4145-01 |
| 100-5 | 11575. | .2547+02 | .2749+05 | .6523-01 | .5781+03 | .7001+06 | .5140-01 |
| 100-6 | 11575. | .2504+02 | .1971+05 | .3021-01 | .4022+03 | .4870+06 | .3422-01 |
| 100-7 | 11575. | .1854+02 | .6414+05 | .3551+00 | .9819+03 | .1189+07 | .1647+00 |
| 100-8 | 11691. | .2459+02 | .2621+05 | .5933-01 | .5324+03 | .6447+06 | .5076-01 |
| 100-9 | 11691. | .2232+02 | .4238+05 | .1556+00 | .7810+03 | .9458+06 | .9042-01 |
| 100-10 | 11652. | .3182+02 | .1023+05 | .9038-02 | .2688+03 | .3256+06 | .1531-01 |
| 100-11 | 11652. | .2755+02 | .1756+05 | .2663-01 | .3995+03 | .4838+06 | .3035-01 |
| 100-12 | 11652. | .2205+02 | .4490+05 | .1740+00 | .8167+03 | .9891+06 | .9705-01 |
| 100-13 | 11652. | .3531+02 | .4785+04 | .1977-02 | .1395+03 | .1690+06 | .6454-02 |
| 100-14 | 11652. | .3393+02 | .6074+04 | .3185-02 | .1704+03 | .2064+06 | .8511-02 |
| 100-15 | 11652. | .3482+02 | .4039+04 | .1408-02 | .1161+03 | .1406+06 | .5524-02 |
| 100-16 | 11652. | .3148+02 | .1012+05 | .8846-02 | .2631+03 | .3186+06 | .1531-01 |
| 100-17 | 11652. | .4301+02 | .1442+04 | .1794-03 | .5096+02 | .6171+05 | .1604-02 |
| 100-18 | 11652. | .3506+02 | .4733+04 | .1934-02 | .1370+03 | .1659+06 | .6428-02 |
| 100-19 | 11652. | .3257+02 | .6646+04 | .3813-02 | .1787+03 | .2165+06 | .9717-02 |
| 100-20 | 11652. | .3702+02 | .1503+04 | .1950-03 | .4594+02 | .5564+05 | .1934-02 |
| 100-21 | 11652. | .3381+02 | .5266+04 | .2394-02 | .1470+03 | .1780+06 | .7418-02 |
| 100-22 | 11652. | .3368+02 | .1355+05 | .1609-01 | .3390+03 | .4106+06 | .2161-01 |
| 100-23 | 11575. | .3591+02 | .1656+04 | .2369-03 | .4912+02 | .5948+05 | .2197-02 |
| 100-24 | 11575. | .3420+02 | .3900+04 | .1313-02 | .1101+03 | .1334+06 | .5431-02 |
| 100-25 | 11575. | .3434+02 | .5930+04 | .3036-02 | .1682+03 | .2036+06 | .8224-02 |
| 100-26 | 11613. | .3382+02 | .3476+04 | .1043-02 | .9709+02 | .1176+06 | .4895-02 |
| 100-27 | 11613. | .3224+02 | .6442+04 | .3582-02 | .1715+03 | .2077+06 | .9515-02 |
| 100-28 | 11613. | .3874+02 | .1012+04 | .8846-04 | .3238+02 | .3921+05 | .1244-02 |
| 100-29 | 11613. | .3305+02 | .5215+03 | .2348-04 | .1639+02 | .1984+05 | .6526-03 |
| 100-30 | 11613. | .3768+02 | .1902+04 | .3123-03 | .5917+02 | .7165+05 | .2404-02 |
| 100-31 | 11652. | .3354+02 | .5010+04 | .2167-02 | .1388+03 | .1680+06 | .7114-02 |
| 100-32 | 11652. | .3135+02 | .7285+04 | .4582-02 | .1886+03 | .2284+06 | .1107-01 |
| 100-33 | 11652. | .3917+02 | .1840+04 | .2924-03 | .5953+02 | .7209+05 | .2238-02 |
| 100-34 | 11652. | .3950+02 | .8896+03 | .6832-04 | .2902+02 | .3514+05 | .1072-02 |
| 100-35 | 11652. | .3736+02 | .2625+04 | .3538-03 | .6250+02 | .7569+05 | .2579-02 |
| 100-36 | 11613. | .2957+02 | .1267+05 | .1257-01 | .2946+03 | .3567+06 | .1943-01 |
| 100-37 | 11652. | .3461+02 | .4959+04 | .2123-02 | .1417+03 | .1716+06 | .6823-02 |
| 100-38 | 11652. | .2519+02 | .1411+05 | .1719-01 | .3284+03 | .3978+06 | .2384-01 |
| 100-39 | 11652. | .3316+02 | .7423+04 | .4757-02 | .2029+03 | .2457+06 | .1068-01 |
| 100-40 | 11652. | .2784+02 | .1649+05 | .2347-01 | .3791+03 | .4591+06 | .2820-01 |
| 100-41 | 11652. | .3410+02 | .5930+04 | .3936-02 | .1670+03 | .2023+06 | .8281-02 |
| 100-42 | 11652. | .3226+02 | .6742+04 | .6598-02 | .2330+03 | .2822+06 | .1290-01 |
| 100-43 | 21193. | .1020+03 | .5772+04 | .2876-02 | .4899+03 | .5933+06 | .2674-02 |
| 100-44 | 21193. | .6662+02 | .1063+05 | .9759-02 | .5848+03 | .7083+06 | .7600-02 |
| 100-45 | 21349. | .7164+02 | .4966+04 | .2073-02 | .2899+03 | .3511+06 | .3257-02 |
| 100-46 | 21349. | .5845+02 | .9940+04 | .8531-02 | .4798+03 | .5810+06 | .8098-02 |
| 100-47 | 21349. | .6542+02 | .4996+04 | .2157-02 | .2924+03 | .3420+06 | .3479-02 |
| 100-48 | 21349. | .6396+02 | .9604+04 | .7964-02 | .5072+03 | .6143+06 | .7151-02 |
| 100-49 | 21349. | .4917+02 | .2276+05 | .4450-01 | .9218+03 | .1116+07 | .2199-01 |
| 100-50 | 21349. | .4722+02 | .2377+05 | .4876-01 | .9267+03 | .1122+07 | .2397-01 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100-51 | 21349. | .5 79+02 | .1823+05 | .2869-01 | .7644+03 | .9258+06 | .1709-01 |
| 100-52 | 21349. | .6671+02 | .1013+05 | .8854-02 | .5746+03 | .6959+06 | .7018-02 |
| 100-53 | 21349. | .5760+02 | .1204+05 | .1252-01 | .5747+03 | .6960+06 | .9920-02 |
| 100-54 | 21349. | .5385+02 | .1708+05 | .2519-01 | .7596+03 | .9199+06 | .1510-01 |
| 100-55 | 21349. | .4576+02 | .2695+05 | .6271-01 | .1017+04 | .1232+07 | .2809-01 |
| 100-56 | 21193. | .6713+02 | .7269+04 | .4561-02 | .4029+03 | .4880+06 | .5156-02 |
| 100-57 | 21193. | .7582+02 | .3920+04 | .1327-02 | .2454+03 | .2971+06 | .2453-02 |
| 100-58 | 21193. | .8506+02 | .1960+04 | .3317-03 | .1425+03 | .1726+06 | .1060-02 |
| 100-59 | 21193. | .6513+02 | .8543+04 | .6300-02 | .4594+03 | .5564+06 | .6246-02 |
| 100-60 | 21193. | .5720+02 | .1335+05 | .1538-01 | .6314+03 | .7647+06 | .1110-01 |
| 100-61 | 21274. | .7379+02 | .4881+04 | .2057-02 | .2974+03 | .3602+06 | .3150-02 |
| 100-62 | 21274. | .6250+02 | .9392+04 | .7598-02 | .4842+03 | .5863+06 | .7148-02 |
| 100-63 | 21274. | .7863+02 | .3814+04 | .1256-02 | .2476+03 | .2999+06 | .2310-02 |
| 100-64 | 21274. | .7335+02 | .5898+04 | .3004-02 | .3573+03 | .4327+06 | .3829-02 |
| 100-65 | 21274. | .8164+02 | .2237+04 | .4322-03 | .1508+03 | .1826+06 | .1305-02 |
| 100-66 | 21349. | .8497+02 | .1678+04 | .2431-03 | .1177+03 | .1426+06 | .9404-03 |
| 100-67 | 21349. | .8467+02 | .8771+03 | .6642-04 | .6147+02 | .7444+05 | .4922-03 |
| 100-68 | 21349. | .8967+02 | .1259+04 | .1367-03 | .9256+02 | .1121+06 | .6728-03 |
| 100-69 | 21349. | .7916+02 | .2860+04 | .7063-03 | .1870+03 | .2264+06 | .1721-02 |
| 100-70 | 21349. | .7128+02 | .3565+04 | .1109-02 | .2110+03 | .2555+06 | .2395-02 |

1318-88-7,CAP4,100F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5320. | .3466+02 | .6769+03 | .6080-04 | .3997+03 | .2346+05 | .1429-02 |
| 100-2 | 5320. | .3088+02 | .9778+03 | .1269-03 | .5144+03 | .3019+05 | .2318-02 |
| 100-3 | 5243. | .3087+02 | .9728+03 | .1256-03 | .5116+03 | .3003+05 | .2306-02 |
| 100-4 | 5320. | .3056+02 | .9502+03 | .1198-03 | .4948+03 | .2904+05 | .2276-02 |
| 100-5 | 5243. | .3198+02 | .8775+03 | .1022-03 | .4780+03 | .2806+05 | .2009-02 |
| 100-6 | 5243. | .3272+02 | .5064+03 | .3403-04 | .2823+03 | .1657+05 | .1133-02 |

1318-88-7,CAP4,210F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-7 | 5320. | .5403+01 | .4101+04 | .2158-02 | .3775+03 | .2216+05 | .5372-01 |
| 210-8 | 5320. | .5096+01 | .6151+04 | .4855-02 | .5341+03 | .3135+05 | .8543-01 |
| 210-9 | 5320. | .5130+01 | .7262+04 | .6767-02 | .6348+03 | .3726+05 | .1002+00 |
| 210-10 | 5320. | .5401+01 | .4528+04 | .2631-02 | .4167+03 | .2446+05 | .5934-01 |
| 210-11 | 5320. | .4955+01 | .8117+04 | .8453-02 | .6852+03 | .4022+05 | .1159+00 |
| 210-12 | 5320. | .5183+01 | .3896+04 | .1947-02 | .3440+03 | .2019+05 | .5320-01 |
| 210-13 | 5320. | .5136+01 | .6664+04 | .5698-02 | .5831+03 | .3423+05 | .9183-01 |

1318-88-7,CAP4,300F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-14 | 5204. | .2313+01 | .6493+04 | .5081-02 | .2559+03 | .1502+05 | .1866+00 |
| 300-15 | 5204. | .2300+01 | .1384+05 | .2309-01 | .5423+03 | .3183+05 | .4001+00 |
| 300-18 | 5204. | .2324+01 | .5297+04 | .3382-02 | .2097+03 | .1231+05 | .1515+00 |
| 300-19 | 5204. | .2267+01 | .2101+04 | .5321-03 | .8116+02 | .4763+04 | .6161-01 |
| 300-20 | 5204. | .2424+01 | .6569+03 | .5200-04 | .2712+02 | .1592+04 | .1802-01 |
| 300-21 | 5204. | .2327+01 | .1254+04 | .1894-03 | .4969+02 | .2916+04 | .3582-01 |

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*****************************************************AVERAGED DATA POINTS*******

1318-88-7,CAP4,100F

P (PSI)                V (CP)
    .00000          .17750+04
    .52817+04       .31944+04

ALPHA STAR AND ALPHA OT MUST BE CALCULATED  BY HAND

1318-88-7,CAP4,210F

P (PSI)                V (CP)
    .00000          .32000+03
    .53204+04       .51863+03

ALPHA STAR AND ALPHA OT MUST BE CALCULATED  BY HAND

1318-88-7,CAP4,300F

P (PSI)                V (CP)
    .00000          .13750+03
    .52044+04       .23256+03

ALPHA STAR AND ALPHA OT MUST BE CALCULATED  BY HAND
```

1318-88-8,CAP4,100F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5320. | .1903+02 | .1104+04 | .1667-03 | .3579+03 | .2100+05 | .4378-02 |
| 100-2 | 5320. | .1976+02 | .1702+04 | .3965-03 | .5732+03 | .3364+05 | .6500-02 |
| 100-3 | 5282. | .1868+02 | .9575+03 | .1254-03 | .3047+03 | .1768+05 | .3869-02 |
| 100-4 | 5282. | .1882+02 | .1596+04 | .3485-03 | .5116+03 | .3003+05 | .6401-02 |
| 100-5 | 5282. | .1982+02 | .6702+03 | .6147-04 | .2263+03 | .1329+05 | .2552-02 |
| 100-6 | 11020. | .3230+02 | .6782+03 | .6294-04 | .3732+03 | .2191+05 | .1585-02 |
| 100-7 | 11020. | .3306+02 | .1237+04 | .2093-03 | .6966+03 | .4088+05 | .2824-02 |
| 100-8 | 11059. | .3227+02 | .5107+03 | .3568-04 | .2808+03 | .1648+05 | .1194-02 |
| 100-9 | 11059. | .3156+02 | .7660+03 | .8028-04 | .4119+03 | .2418+05 | .1832-02 |
| 100-10 | 11059. | .3515+02 | .9256+03 | .1172-03 | .5542+03 | .3253+05 | .1988-02 |
| 100-11 | 11059. | .3365+02 | .1729+04 | .4089-03 | .9911+03 | .5817+05 | .3878-02 |
| 100-12 | 11117. | .3504+02 | .3259+03 | .1453-04 | .1946+03 | .1142+05 | .7019-03 |
| 100-13 | 11117. | .3556+02 | .6920+03 | .6551-04 | .4192+03 | .2461+05 | .1469-02 |
| 100-14 | 20445. | .7309+02 | .2228+03 | .6790-05 | .2774+03 | .1628+05 | .2300-03 |
| 100-15 | 20445. | .7781+02 | .3487+03 | .1664-04 | .4623+03 | .2713+05 | .3382-03 |
| 100-16 | 20445. | .7958+02 | .5519+03 | .4168-04 | .7483+03 | .4392+05 | .5234-03 |
| 100-17 | 20369. | .8112+02 | .3236+03 | .1433-04 | .4473+03 | .2625+05 | .3011-03 |
| 100-18 | 20369. | .8064+02 | .5720+03 | .4476-04 | .7858+03 | .4612+05 | .5354-03 |
| 100-19 | 20369. | .7469+02 | .6322+03 | .5468-04 | .8044+03 | .4722+05 | .6388-03 |
| 100-20 | 20369. | .7614+02 | .7375+03 | .7443-04 | .9568+03 | .5616+05 | .7311-03 |
| 100-21 | 20369. | .7587+02 | .7325+03 | .7342-04 | .9468+03 | .5557+05 | .7287-03 |
| 100-22 | 29339. | .1542+03 | .1641+03 | .3683-05 | .4309+03 | .2529+05 | .8032-04 |
| 100-23 | 29339. | .1517+03 | .2619+03 | .9385-05 | .6769+03 | .3973+05 | .1303-03 |
| 100-24 | 29339. | .1499+03 | .3131+03 | .1341-04 | .7993+03 | .4692+05 | .1577-03 |
| 100-25 | 29339. | .1617+03 | .1505+03 | .3100-05 | .4146+03 | .2434+05 | .7026-04 |
| 100-26 | 29339. | .1682+03 | .2228+03 | .6790-05 | .6382+03 | .3746+05 | .9998-04 |
| 100-27 | 35822. | .2465+03 | .7769+02 | .8258-06 | .3263+03 | .1915+05 | .2379-04 |
| 100-28 | 35822. | .2836+03 | .9358+02 | .1198-05 | .4522+03 | .2654+05 | .2490-04 |
| 100-29 | 35822. | .2511+03 | .1057+03 | .1529-05 | .4522+03 | .2654+05 | .3177-04 |
| 100-30 | 35822. | .2313+03 | .1189+03 | .1934-05 | .4685+03 | .2750+05 | .3880-04 |
| 100-31 | 40194. | .4243+03 | .3319+02 | .1508-06 | .2399+03 | .1408+05 | .5905-05 |
| 100-32 | 40194. | .3342+03 | .7416+02 | .7525-06 | .4222+03 | .2478+05 | .1675-04 |
| 100-33 | 40043. | .2990+03 | .8240+02 | .9290-06 | .4198+03 | .2464+05 | .2080-04 |
| 100-34 | 40043. | .3061+03 | .7475+02 | .7645-06 | .3898+03 | .2288+05 | .1843-04 |
| 100-35 | 50445. | .5899+03 | .3814+02 | .1990-06 | .3833+03 | .2250+05 | .4879-05 |
| 100-36 | 50445. | .4826+03 | .7475+02 | .7645-06 | .6146+03 | .3607+05 | .1169-04 |
| 100-37 | 50445. | .5725+03 | .5768+02 | .4552-06 | .5626+03 | .3302+05 | .7604-05 |
| 100-38 | 50445. | .6035+03 | .6239+02 | .5326-06 | .6415+03 | .3765+05 | .7802-05 |
| 100-39 | 50445. | .5901+03 | .6651+02 | .6052-06 | .6686+03 | .3924+05 | .8507-05 |

1318-88-8,CAP4,210F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-1 | 5389. | .5449+01 | .1965+04 | .5096-03 | .1824+03 | .1071+05 | .2625-01 |
| 210-2 | 5389. | .4801+01 | .5276+04 | .3674-02 | .4315+03 | .2533+05 | .6000-01 |
| 210-3 | 5389. | .4715+01 | .2557+04 | .8630-03 | .2054+03 | .1206+05 | .3948-01 |
| 210-4 | 5389. | .4671+01 | .1938+04 | .4957-03 | .1542+03 | .9052+04 | .3021-01 |
| 210-5 | 5389. | .4831+01 | .3473+04 | .1591-02 | .2858+03 | .1678+05 | .5232-01 |
| 210-6 | 11334. | .7348+01 | .2261+04 | .6747-03 | .2831+03 | .1662+05 | .2240-01 |
| 210-7 | 11256. | .7418+01 | .2100+04 | .5818-03 | .2654+03 | .1558+05 | .2060-01 |
| 210-8 | 11256. | .7214+01 | .3526+04 | .1641-02 | .4334+03 | .2544+05 | .3558-01 |
| 210-9 | 11256. | .7601+01 | .1561+04 | .3217-03 | .2022+03 | .1187+05 | .1495-01 |
| 210-10 | 11256. | .7634+01 | .3284+04 | .1423-02 | .4271+03 | .2507+05 | .3132-01 |
| 210-12 | 19505. | .1357+02 | .2088+04 | .5753-03 | .4826+03 | .2832+05 | .1120-01 |
| 210-13 | 19505. | .1296+02 | .2971+04 | .1165-02 | .6560+03 | .3851+05 | .1669-01 |
| 210-14 | 19505. | .1356+02 | .1338+04 | .2364-03 | .3091+03 | .1814+05 | .7186-02 |
| 210-15 | 19505. | .1321+02 | .2356+04 | .7322-03 | .5303+03 | .3113+05 | .1298-01 |
| 210-16 | 29816. | .2410+02 | .7870+03 | .8173-04 | .3232+03 | .1897+05 | .2377-02 |
| 210-17 | 29816. | .2475+02 | .1020+04 | .1373-03 | .4301+03 | .2524+05 | .2999-02 |
| 210-18 | 29816. | .2323+02 | .1258+04 | .2089-03 | .4978+03 | .2922+05 | .3943-02 |
| 210-19 | 29816. | .2322+02 | .1901+04 | .4767-03 | .7518+03 | .4412+05 | .5959-02 |
| 210-20 | 29816. | .2400+02 | .2797+04 | .1033-02 | .1144+04 | .6714+05 | .8483-02 |
| 210-21 | 39824. | .4288+02 | .6813+03 | .6125-04 | .4978+03 | .2922+05 | .1156-02 |
| 210-22 | 39824. | .4249+02 | .4845+03 | .3097-04 | .3507+03 | .2058+05 | .8299-03 |
| 210-23 | 39824. | .3977+02 | .8125+03 | .8711-04 | .5506+03 | .3232+05 | .1487-02 |
| 210-24 | 39824. | .4351+02 | .4239+03 | .2371-04 | .3142+03 | .1844+05 | .7092-03 |
| 210-25 | 39824. | .4283+02 | .7166+03 | .6776-04 | .5229+03 | .3069+05 | .1218-02 |
| 210-26 | 49529. | .6662+02 | .1696+03 | .3794-05 | .1925+03 | .1130+05 | .1853-03 |
| 210-27 | 49529. | .6535+02 | .3331+03 | .1464-04 | .3708+03 | .2176+05 | .3710-03 |
| 210-28 | 49529. | .6840+02 | .3911+03 | .2019-04 | .4558+03 | .2675+05 | .4162-03 |
| 210-29 | 49529. | .6785+02 | .4971+03 | .3261-04 | .5746+03 | .3373+05 | .5333-03 |
| 210-30 | 49529. | .6840+02 | .2019+03 | .5377-05 | .2352+03 | .1381+05 | .2148-03 |

1318-88-8,CAP4,300F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5311. | .2295+01 | .6226+04 | .4898-02 | .2434+03 | .1429+05 | .1891+00 |
| 300-2 | 5311. | .2218+01 | .1038+05 | .1361-01 | .3921+03 | .2301+05 | .3261+00 |
| 300-3 | 5311. | .2582+01 | .5534+04 | .3870-02 | .2434+03 | .1429+05 | .1494+00 |
| 300-4 | 5311. | .2197+01 | .1263+05 | .2014-01 | .4726+03 | .2774+05 | .4005+00 |
| 300-5 | 5311. | .2169+01 | .1876+05 | .4449-01 | .6933+03 | .4069+05 | .6031+00 |
| 300-6 | 11451. | .3582+01 | .3500+04 | .1547-02 | .2135+03 | .1253+05 | .6810-01 |
| 300-7 | 11451. | .3389+01 | .6784+04 | .5815-02 | .3917+03 | .2299+05 | .1395+00 |
| 300-8 | 11412. | .3570+01 | .4549+04 | .2615-02 | .2767+03 | .1624+05 | .8882-01 |
| 300-9 | 11412. | .3636+01 | .2611+04 | .8615-03 | .1617+03 | .9493+04 | .5006-01 |
| 300-10 | 11412. | .3492+01 | .6541+04 | .5407-02 | .3892+03 | .2284+05 | .1306+00 |
| 300-11 | 20111. | .6006+01 | .2382+04 | .7172-03 | .2438+03 | .1431+05 | .2765-01 |
| 300-12 | 20111. | .5731+01 | .4685+04 | .2773-02 | .4574+03 | .2685+05 | .5697-01 |
| 300-13 | 19960. | .5940+01 | .4122+04 | .2147-02 | .4172+03 | .2449+05 | .4837-01 |
| 300-14 | 19656. | .6059+01 | .2556+04 | .8258-03 | .2639+03 | .1549+05 | .2941-01 |
| 300-15 | 19656. | .6432+01 | .5595+04 | .3955-02 | .6131+03 | .3599+05 | .6062-01 |
| 300-16 | 29665. | .1011+02 | .1446+04 | .2640-03 | .2489+03 | .1461+05 | .9970-02 |
| 300-17 | 29665. | .1001+02 | .2463+04 | .7664-03 | .4198+03 | .2464+05 | .1715-01 |
| 300-18 | 29665. | .9163+01 | .3962+04 | .1983-02 | .6184+03 | .3630+05 | .3014-01 |
| 300-19 | 29665. | .9875+01 | .2436+04 | .7498-03 | .4098+03 | .2406+05 | .1719-01 |
| 300-20 | 29665. | .9304+01 | .3855+04 | .1878-02 | .6110+03 | .3586+05 | .2888-01 |
| 300-21 | 41341. | .1578+02 | .2329+04 | .6853-03 | .6262+03 | .3676+05 | .1028-01 |
| 300-22 | 41341. | .1675+02 | .1713+04 | .3709-03 | .4889+03 | .2870+05 | .7129-02 |
| 300-23 | 41341. | .1660+02 | .1325+04 | .2219-03 | .3747+03 | .2199+05 | .5564-02 |
| 300-24 | 41341. | .1831+02 | .1499+04 | .2839-03 | .4676+03 | .2745+05 | .5707-02 |
| 300-25 | 41341. | .1609+02 | .1954+04 | .4825-03 | .5356+03 | .3144+05 | .8465-02 |
| 300-26 | 49226. | .2155+02 | .8967+03 | .1016-03 | .3293+03 | .1933+05 | .2900-02 |
| 300-27 | 49226. | .2162+02 | .1472+04 | .2739-03 | .5423+03 | .3183+05 | .4746-02 |
| 300-28 | 49226. | .2164+02 | .1807+04 | .4125-03 | .6663+03 | .3911+05 | .5819-02 |
| 300-29 | 49226. | .2132+02 | .1901+04 | .4564-03 | .6902+03 | .4051+05 | .6214-02 |
| 300-30 | 49226. | .2302+02 | .1017+04 | .1307-03 | .3989+03 | .2341+05 | .3080-02 |
| 300-31 | 64845. | .4019+02 | .5904+03 | .4405-04 | .4043+03 | .2373+05 | .1024-02 |
| 300-32 | 64769. | .3884+02 | .1035+04 | .1352-03 | .6846+03 | .4018+05 | .1857-02 |
| 300-33 | 64769. | .4021+02 | .6788+03 | .5822-04 | .4649+03 | .2729+05 | .1177-02 |
| 300-34 | 64769. | .3950+02 | .8478+03 | .9083-04 | .5705+03 | .3349+05 | .1496-02 |
| 300-35 | 64769. | .4016+02 | .8630+03 | .9410-04 | .5904+03 | .3465+05 | .1498-02 |
| 300-36 | 73943. | .5338+02 | .2902+03 | .1064-04 | .2639+03 | .1549+05 | .3789-03 |
| 300-37 | 73943. | .5504+02 | .4819+03 | .2935-04 | .4519+03 | .2653+05 | .6103-03 |
| 300-38 | 73185. | .4966+02 | .5047+03 | .3218-04 | .4270+03 | .2506+05 | .7083-03 |
| 300-39 | 72882. | .5106+02 | .5450+03 | .3754-04 | .4741+03 | .2763+05 | .7440-03 |
| 300-40 | 78492. | .5878+02 | .2321+03 | .6809-05 | .2325+03 | .1364+05 | .2753-03 |
| 300-41 | 78492. | .6514+02 | .4517+03 | .2578-04 | .5013+03 | .2942+05 | .4833-03 |
| 300-42 | 78492. | .6480+02 | .3734+03 | .1762-04 | .4123+03 | .2420+05 | .4017-03 |
| 300-43 | 78796. | .6472+02 | .4769+03 | .2874-04 | .5258+03 | .3086+05 | .5136-03 |

**********************************************************AVERAGED DATA POINTS*********

1318-88-8,CAP4,100F

| P (PSI) | V (CP) |
|---|---|
| .00000 | .11100+04 |
| .52972+04 | .19222+04 |
| .11064+05 | .33575+04 |
| .20397+05 | .77367+04 |
| .29339+05 | .15712+05 |
| .39025+05 | .30572+05 |
| .50445+05 | .56773+05 |

ALPHA STAR= .93534-04
ALPHA OT= .11273-03

1318-88-8,CAP4,210F

| P (PSI) | V (CP) |
|---|---|
| .00000 | .26000+03 |
| .53892+04 | .48933+03 |
| .11271+05 | .74429+03 |
| .19505+05 | .13324+04 |
| .29816+05 | .23859+04 |
| .39824+05 | .42297+04 |
| .49529+05 | .67324+04 |

ALPHA STAR= .82747-04
ALPHA OT= .16224-03

1318-88-8,CAP4,300F

| P (PSI) | V (CP) |
|---|---|
| .00000 | .12500+03 |
| .53110+04 | .22921+03 |
| .11428+05 | .35337+03 |
| .19899+05 | .60339+03 |
| .29665+05 | .96907+03 |
| .41341+05 | .15706+04 |
| .49226+05 | .21830+04 |
| .64784+05 | .39777+04 |
| .73488+05 | .52286+04 |
| .78568+05 | .63358+04 |

ALPHA STAR= .74668-04
ALPHA OT= .15455-03

1318-88-8,CAP1,100F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11147. | .2692+02 | .1379+05 | .1691-01 | .3060+03 | .3713+06 | .2512-01 |
| 100-2 | 11156. | .2199+02 | .2808+05 | .7008-01 | .5099+03 | .6176+06 | .6259-01 |
| 100-3 | 11166. | .2505+02 | .2233+05 | .4433-01 | .4620+03 | .5595+06 | .4370-01 |
| 100-4 | 11166. | .2072+02 | .3449+05 | .1057+00 | .5899+03 | .7144+06 | .8160-01 |
| 100-5 | 11147. | .2081+02 | .3235+05 | .9301-01 | .5560+03 | .6734+06 | .7619-01 |
| 100-6 | 11147. | .1786+02 | .5173+05 | .2378+00 | .7631+03 | .9241+06 | .1419+00 |
| 100-7 | 11108. | .2382+02 | .1806+05 | .2900-01 | .3553+03 | .4303+06 | .3717-01 |
| 100-8 | 11108. | .1821+02 | .5419+05 | .2610+00 | .8151+03 | .9871+06 | .1458+00 |
| 100-9 | 11108. | .1464+02 | .8704+05 | .6732+00 | .1052+04 | .1274+07 | .2914+00 |
| 100-10 | 11081. | .2986+02 | .2863+04 | .7284-03 | .7059+02 | .8549+05 | .4700-02 |
| 100-11 | 11061. | .2847+02 | .5419+04 | .2610-02 | .1274+03 | .1543+06 | .9330-02 |
| 100-12 | 11081. | .2942+02 | .1892+04 | .3180-03 | .4595+02 | .5565+05 | .3152-02 |
| 100-13 | 11081. | .2750+02 | .6902+04 | .4233-02 | .1567+03 | .1898+06 | .1230-01 |
| 100-14 | 11030. | .2826+02 | .9816+03 | .8562-04 | .2290+02 | .2774+05 | .1703-02 |
| 100-15 | 11030. | .2946+02 | .2249+04 | .4497-03 | .5472+02 | .6627+05 | .3743-02 |
| 100-16 | 11030. | .3130+02 | .2889+04 | .7414-03 | .7464+02 | .9040+05 | .4524-02 |
| 100-17 | 22520. | .5956+02 | .6019+04 | .3220-02 | .2960+03 | .3585+06 | .4954-02 |
| 100-18 | 22520. | .5582+02 | .1026+05 | .9361-02 | .4731+03 | .5729+06 | .9013-02 |
| 100-19 | 22520. | .6919+02 | .3961+04 | .1394-02 | .2263+03 | .2741+06 | .2806-02 |
| 100-20 | 22520. | .5799+02 | .7974+04 | .5651-02 | .3818+03 | .4624+06 | .6741-02 |
| 100-21 | 22520. | .4709+02 | .2120+05 | .3992-01 | .8242+03 | .9982+06 | .2206-01 |
| 100-22 | 22520. | .5059+02 | .1492+05 | .1978-01 | .6232+03 | .7547+06 | .1446-01 |
| 100-23 | 22520. | .4300+02 | .2727+05 | .6607-01 | .9682+03 | .1172+07 | .3108-01 |
| 100-24 | 22520. | .4943+02 | .1795+05 | .2865-01 | .7329+03 | .8876+06 | .1780-01 |
| 100-25 | 22520. | .5356+02 | .1368+05 | .1664-01 | .6053+03 | .7330+06 | .1252-01 |
| 100-26 | 22367. | .8421+02 | .1837+04 | .2998-03 | .1277+03 | .1547+06 | .1069-02 |
| 100-27 | 22367. | .7303+02 | .3287+04 | .9604-03 | .1983+03 | .2401+06 | .2206-02 |
| 100-28 | 22367. | .8590+02 | .6220+03 | .3438-04 | .4412+02 | .5343+05 | .3549-03 |
| 100-29 | 22367. | .8885+02 | .1266+04 | .1423-03 | .9285+02 | .1125+06 | .6982-03 |

1318-88-9,CAP4,100F,6-16-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5296. | .1713+02 | .1637+04 | .3551-03 | .4778+03 | .2804+05 | .6984-02 |
| 100-2 | 5258. | .1758+02 | .1769+04 | .4146-03 | .5299+03 | .3110+05 | .7332-02 |
| 100-3 | 5258. | .1669+02 | .1313+04 | .2283-03 | .3734+03 | .2192+05 | .5746-02 |
| 100-4 | 5258. | .1732+02 | .1666+04 | .3675-03 | .4915+03 | .2885+05 | .7026-02 |
| 100-5 | 5296. | .1724+02 | .1655+04 | .3627-03 | .4859+03 | .2852+05 | .7014-02 |
| 100-6 | 5258. | .1655+02 | .1792+04 | .4252-03 | .5052+03 | .2966+05 | .7909-02 |
| 100-8 | 11521. | .3410+02 | .4729+03 | .2962-04 | .2747+03 | .1612+05 | .1013-02 |
| 100-9 | 11521. | .3022+02 | .1005+04 | .1337-03 | .5174+03 | .3037+05 | .2429-02 |
| 100-10 | 11484. | .3030+02 | .5320+03 | .3748-04 | .2747+03 | .1612+05 | .1282-02 |
| 100-11 | 11484. | .3094+02 | .7211+03 | .6887-04 | .3801+03 | .2231+05 | .1703-02 |
| 100-12 | 11446. | .3135+02 | .9871+03 | .1291-03 | .5272+03 | .3095+05 | .2300-02 |
| 100-13 | 11446. | .3136+02 | .7664+03 | .7780-04 | .4095+03 | .2404+05 | .1785-02 |
| 100-14 | 11446. | .3063+02 | .1724+04 | .3938-03 | .8999+03 | .5282+05 | .4113-02 |
| 100-15 | 11446. | .3146+02 | .1450+04 | .2785-03 | .7773+03 | .4562+05 | .3367-02 |
| 100-16 | 11446. | .3201+02 | .1160+04 | .1782-03 | .6326+03 | .3713+05 | .2648-02 |
| 100-17 | 11446. | .2821+02 | .1724+04 | .3938-03 | .8288+03 | .4865+05 | .4466-02 |
| 100-18 | 11256. | .3100+02 | .1685+04 | .3761-03 | .8900+03 | .5224+05 | .3972-02 |
| 100-19 | 19015. | .5754+02 | .3472+03 | .1596-04 | .3403+03 | .1997+05 | .4408-03 |
| 100-20 | 19161. | .6415+02 | .3865+03 | .1978-04 | .4224+03 | .2479+05 | .4401-03 |
| 100-21 | 19161. | .5743+02 | .9250+03 | .1133-03 | .9051+03 | .5313+05 | .1177-02 |
| 100-22 | 19015. | .6311+02 | .6981+03 | .6455-04 | .7507+03 | .4406+05 | .8081-03 |
| 100-23 | 19161. | .5732+02 | .9541+03 | .1206-03 | .9317+03 | .5469+05 | .1216-02 |
| 100-25 | 29358. | .1469+03 | .1842+03 | .4495-05 | .4611+03 | .2706+05 | .9162-04 |
| 100-26 | 29358. | .1367+03 | .3975+03 | .2093-04 | .9257+03 | .5434+05 | .2125-03 |
| 100-27 | 29358. | .1385+03 | .2608+03 | .9010-05 | .6156+03 | .3613+05 | .1376-03 |
| 100-28 | 29358. | .1306+03 | .3384+03 | .1517-04 | .7532+03 | .4421+05 | .1892-03 |
| 100-29 | 29358. | .1315+03 | .3878+03 | .1992-04 | .8691+03 | .5101+05 | .2154-03 |
| 100-30 | 29358. | .1301+03 | .1988+03 | .5233-05 | .4405+03 | .2586+05 | .1116-03 |
| 100-31 | 39992. | .2593+03 | .1393+03 | .2571-05 | .6156+03 | .3613+05 | .3926-04 |
| 100-32 | 39846. | .2839+03 | .1877+03 | .4665-05 | .9077+03 | .5328+05 | .4830-04 |
| 100-33 | 39846. | .2251+03 | .1354+03 | .2427-05 | .5190+03 | .3046+05 | .4394-04 |
| 100-34 | 39701. | .2498+03 | .2161+03 | .6186-05 | .9198+03 | .5399+05 | .6320-04 |
| 100-35 | 39701. | .2575+03 | .1536+03 | .3123-05 | .6735+03 | .3953+05 | .4357-04 |
| 100-36 | 50335. | .4744+03 | .6370+02 | .5374-06 | .5149+03 | .3022+05 | .9808-05 |
| 100-37 | 50335. | .4384+03 | .5687+02 | .4284-06 | .4248+03 | .2493+05 | .9477-05 |
| 100-38 | 50189. | .5165+03 | .1046+03 | .1450-05 | .9208+03 | .5405+05 | .1480-04 |
| 100-39 | 50189. | .5716+03 | .9896+02 | .1297-05 | .9636+03 | .5656+05 | .1265-04 |
| 100-40 | 50189. | .6047+03 | .9099+02 | .1097-05 | .9375+03 | .5502+05 | .1099-04 |
| 100-41 | 50189. | .5547+03 | .7848+02 | .8158-06 | .7417+03 | .4353+05 | .1034-04 |
| 100-42 | 50189. | .5263+03 | .9896+02 | .1297-05 | .8872+03 | .5208+05 | .1374-04 |
| 100-43 | 61698. | .1183+04 | .4095+02 | .2221-06 | .8254+03 | .4845+05 | .2528-05 |
| 100-44 | 61406. | .1032+04 | .5289+02 | .3705-06 | .9301+03 | .5459+05 | .3744-05 |
| 100-45 | 61334. | .1089+04 | .4948+02 | .3242-06 | .9181+03 | .5389+05 | .3319-05 |
| 100-46 | 61334. | .1054+04 | .5460+02 | .3948-06 | .9800+03 | .5752+05 | .3786-05 |

1318--88-9,210F,CAP4,6-17-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-1 | 5330. | .3666+01 | .7472+04 | .7122-02 | .4667+03 | .2739+05 | .1434+00 |
| 210-2 | 5330. | .3702+01 | .7092+04 | .6416-02 | .4473+03 | .2625+05 | .1348+00 |
| 210-3 | 5330. | .3686+01 | .4749+04 | .2877-02 | .2982+03 | .1750+05 | .9067-01 |
| 210-4 | 5291. | .3782+01 | .8527+04 | .9276-02 | .5495+03 | .3225+05 | .1587+00 |
| 210-5 | 5291. | .3593+01 | .6585+04 | .5532-02 | .4031+03 | .2366+05 | .1290+00 |
| 210-6 | 5368. | .3708+01 | .7345+04 | .6883-02 | .4640+03 | .2723+05 | .1394+00 |
| 210-7 | 11477. | .5974+01 | .4242+04 | .2296-02 | .4318+03 | .2535+05 | .4997-01 |
| 210-8 | 11515. | .6290+01 | .4352+04 | .2417-02 | .4664+03 | .2738+05 | .4869-01 |
| 210-10 | 11439. | .6200+01 | .1892+04 | .4568-03 | .1999+03 | .1173+05 | .2148-01 |
| 210-11 | 11477. | .5967+01 | .4783+04 | .2919-02 | .4862+03 | .2854+05 | .5642-01 |
| 210-12 | 11477. | .6378+01 | .3248+04 | .1346-02 | .3530+03 | .2072+05 | .3584-01 |
| 210-13 | 20472. | .1113+02 | .2649+04 | .8951-03 | .5023+03 | .2949+05 | .1674-01 |
| 210-14 | 20472. | .1119+02 | .3343+04 | .1426-02 | .6376+03 | .3743+05 | .2101-01 |
| 210-15 | 20472. | .1120+02 | .2469+04 | .7775-03 | .4709+03 | .2764+05 | .1552-01 |
| 210-16 | 20472. | .1130+02 | .1944+04 | .4822-03 | .3743+03 | .2197+05 | .1211-01 |
| 210-17 | 20472. | .1160+02 | .2469+04 | .7775-03 | .4878+03 | .2863+05 | .1498-01 |
| 210-18 | 20326. | .1146+02 | .2746+04 | .9623-03 | .5361+03 | .3147+05 | .1687-01 |
| 210-19 | 35913. | .2852+02 | .9890+03 | .1248-03 | .4806+03 | .2821+05 | .2440-02 |
| 210-20 | 35913. | .2527+02 | .8581+03 | .9394-04 | .3695+03 | .2169+05 | .2389-02 |
| 210-21 | 35913. | .2494+02 | .7330+03 | .6855-04 | .3115+03 | .1828+05 | .2068-02 |
| 210-22 | 35913. | .2566+02 | .1171+04 | .1749-03 | .5119+03 | .3005+05 | .3210-02 |
| 210-23 | 36059. | .2713+02 | .1076+04 | .1478-03 | .4975+03 | .2920+05 | .2792-02 |
| 210-24 | 35913. | .2701+02 | .9236+03 | .1088-03 | .4250+03 | .2495+05 | .2406-02 |
| 210-25 | 50189. | .5214+02 | .4291+03 | .2349-04 | .3812+03 | .2237+05 | .5790-03 |
| 210-26 | 50044. | .5277+02 | .5061+03 | .3268-04 | .4550+03 | .2671+05 | .6750-03 |
| 210-27 | 50044. | .5698+02 | .7388+03 | .6964-04 | .7172+03 | .4210+05 | .9126-03 |
| 210-28 | 50189. | .5247+02 | .5410+03 | .3735-04 | .4837+03 | .2839+05 | .7256-03 |
| 210-29 | 49898. | .5136+02 | .1040+04 | .1380-03 | .9100+03 | .5341+05 | .1425-02 |
| 210-30 | 49898. | .5793+02 | .4654+03 | .2763-04 | .4594+03 | .2696+05 | .5653-03 |
| 210-31 | 68108. | .1148+03 | .2363+03 | .7126-05 | .4621+03 | .2712+05 | .1449-03 |
| 210-32 | 68108. | .1192+03 | .2509+03 | .8030-05 | .5097+03 | .2992+05 | .1481-03 |
| 210-33 | 68108. | .1173+03 | .4909+03 | .3074-04 | .9810+03 | .5758+05 | .2945-03 |
| 210-34 | 68108. | .1105+03 | .4545+03 | .2635-04 | .8553+03 | .5020+05 | .2896-03 |
| 210-35 | 67962. | .1188+03 | .3745+03 | .1789-04 | .7581+03 | .4450+05 | .2218-03 |
| 210-36 | 67962. | .1126+03 | .4945+03 | .3120-04 | .9490+03 | .5570+05 | .3089-03 |
| 210-37 | 77868. | .1684+03 | .1564+03 | .3119-05 | .4485+03 | .2633+05 | .6534-04 |
| 210-38 | 77868. | .1665+03 | .1442+03 | .2652-05 | .4089+03 | .2400+05 | .6095-04 |
| 210-39 | 77722. | .1701+03 | .2286+03 | .6668-05 | .6625+03 | .3888+05 | .9460-04 |
| 210-41 | 77722. | .1684+03 | .2764+03 | .9746-05 | .7931+03 | .4655+05 | .1155-03 |
| 210-42 | 77431. | .1558+03 | .2610+03 | .8693-05 | .6928+03 | .4066+05 | .1179-03 |

1318-88-9,300F,CAP4

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5232. | .1645+01 | .1384+05 | .2347-01 | .3879+03 | .2277+05 | .5687+00 |
| 300-2 | 5232. | .1736+01 | .1677+05 | .3442-01 | .4959+03 | .2911+05 | .6523+00 |
| 300-3 | 5251. | .1771+01 | .6520+04 | .5206-02 | .1967+03 | .1155+05 | .2487+00 |
| 300-4 | 5251. | .1787+01 | .1156+05 | .1636-01 | .3518+03 | .2065+05 | .4370+00 |
| 300-5 | 5270. | .1788+01 | .1105+05 | .1495-01 | .3366+03 | .1976+05 | .4175+00 |
| 300-6 | 5270. | .1718+01 | .1746+05 | .3735-01 | .5112+03 | .3000+05 | .6867+00 |
| 300-7 | 11589. | .2676+01 | .3366+04 | .1387-02 | .1534+03 | .9006+04 | .8498-01 |
| 300-8 | 11589. | .2786+01 | .8552+04 | .8957-02 | .4059+03 | .2383+05 | .2074+00 |
| 300-9 | 11589. | .2726+01 | .6181+04 | .4679-02 | .2871+03 | .1685+05 | .1532+00 |
| 300-10 | 11589. | .2721+01 | .1185+05 | .1721-01 | .5496+03 | .3226+05 | .2943+00 |
| 300-11 | 11589. | .2763+01 | .4996+04 | .3057-02 | .2352+03 | .1381+05 | .1221+00 |
| 300-12 | 11551. | .2671+01 | .1050+05 | .1350-01 | .4778+03 | .2805+05 | .2655+00 |
| 300-13 | 11551. | .2559+01 | .4657+04 | .2656-02 | .2031+03 | .1192+05 | .1229+00 |
| 300-14 | 20903. | .4720+01 | .6386+04 | .4994-02 | .5135+03 | .3014+05 | .9139-01 |
| 300-15 | 20903. | .4407+01 | .4369+04 | .2338-02 | .3280+03 | .1925+05 | .6698-01 |
| 300-16 | 20829. | .4595+01 | .3610+04 | .1596-02 | .2826+03 | .1659+05 | .5306-01 |
| 300-17 | 20829. | .4715+01 | .5231+04 | .3351-02 | .4202+03 | .2466+05 | .7495-01 |
| 300-18 | 20829. | .4546+01 | .4054+04 | .2013-02 | .3140+03 | .1843+05 | .6024-01 |
| 300-19 | 20829. | .4703+01 | .5336+04 | .3487-02 | .4275+03 | .2509+05 | .7665-01 |
| 300-20 | 36387. | .9781+01 | .2485+04 | .7562-03 | .4141+03 | .2430+05 | .1716-01 |
| 300-21 | 36387. | .1002+02 | .2746+04 | .9238-03 | .4689+03 | .2752+05 | .1852-01 |
| 300-22 | 36387. | .1005+02 | .2276+04 | .6342-03 | .3894+03 | .2286+05 | .1530-01 |
| 300-23 | 36387. | .1018+02 | .3060+04 | .1147-02 | .5307+03 | .3115+05 | .2031-01 |
| 300-24 | 36387. | .9671+01 | .1700+04 | .3540-03 | .2801+03 | .1644+05 | .1188-01 |
| 300-25 | 36387. | .1005+02 | .2694+04 | .8889-03 | .4615+03 | .2709+05 | .1810-01 |
| 300-26 | 50834. | .1662+02 | .1412+04 | .2443-03 | .4000+03 | .2348+05 | .5740-02 |
| 300-27 | 50760. | .1667+02 | .2276+04 | .6342-03 | .6463+03 | .3793+05 | .9222-02 |
| 300-28 | 50760. | .1784+02 | .2956+04 | .1070-02 | .8982+03 | .5272+05 | .1119-01 |
| 300-29 | 50760. | .1526+02 | .3322+04 | .1351-02 | .8636+03 | .5069+05 | .1471-01 |
| 300-31 | 50760. | .1652+02 | .1596+04 | .3118-03 | .4491+03 | .2636+05 | .6524-02 |
| 300-32 | 73578. | .3702+02 | .1517+04 | .2819-03 | .9568+03 | .5616+05 | .2768-02 |
| 300-33 | 73356. | .3939+02 | .1059+04 | .1374-03 | .7108+03 | .4172+05 | .1817-02 |
| 300-34 | 73134. | .3960+02 | .1147+04 | .1610-03 | .7735+03 | .4540+05 | .1956-02 |
| 300-35 | 73134. | .4152+02 | .1161+04 | .1652-03 | .8214+03 | .4822+05 | .1889-02 |
| 300-36 | 72837. | .3810+02 | .1243+04 | .1891-03 | .8067+03 | .4735+05 | .2203-02 |
| 300-37 | 72986. | .3996+02 | .1132+04 | .1568-03 | .7705+03 | .4523+05 | .1913-02 |
| 300-38 | 72837. | .3947+02 | .7915+03 | .7671-04 | .5323+03 | .3124+05 | .1354-02 |
| 300-45 | 72541. | .4109+02 | .4561+03 | .2548-04 | .3194+03 | .1874+05 | .7498-03 |
| 300-46 | 72541. | .3754+02 | .6879+03 | .5795-04 | .4399+03 | .2582+05 | .1238-02 |
| 300-47 | 72393. | .3894+02 | .1147+04 | .1610-03 | .7605+03 | .4464+05 | .1989-02 |
| 300-48 | 72467. | .3833+02 | .1139+04 | .1589-03 | .7438+03 | .4366+05 | .2008-02 |
| 300-49 | 72467. | .3898+02 | .1317+04 | .2123-03 | .8744+03 | .5132+05 | .2282-02 |
| 300-39 | 78023. | .4567+02 | .3649+03 | .1631-04 | .2839+03 | .1667+05 | .5397-03 |
| 300-40 | 77875. | .4719+02 | .6805+03 | .5671-04 | .5471+03 | .3211+05 | .9741-03 |
| 300-41 | 77875. | .4807+02 | .8654+03 | .9172-04 | .7088+03 | .4161+05 | .1216-02 |
| 300-42 | 78172. | .4602+02 | .1028+04 | .1295-03 | .8061+03 | .4732+05 | .1509-02 |
| 300-43 | 78468. | .4741+02 | .8691+03 | .9251-04 | .7020+03 | .4120+05 | .1238-02 |
| 300-44 | 78023. | .4563+02 | .1080+04 | .1428-03 | .8395+03 | .4927+05 | .1599-02 |

****************************************************AVERAGED DATA POINTS********

1318-88-9,CAP4,100F,6-16-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .10850+04 |
| .52707+04 | .17084+04 |
| .11449+05 | .31054+04 |
| .19102+05 | .59910+04 |
| .29358+05 | .13573+05 |
| .39817+05 | .25511+05 |
| .50214+05 | .54136+05 |
| .61443+05 | .10895+06 |

ALPHA STAR= .86190-04
ALPHA OT= .85082-04

1318--88-9,210F,CAP4,6-17-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .23500+03 |
| .53232+04 | .36894+03 |
| .11477+05 | .61618+03 |
| .20447+05 | .11313+04 |
| .35937+05 | .26424+04 |
| .50044+05 | .53942+04 |
| .68059+05 | .11554+05 |
| .77722+05 | .16582+05 |

ALPHA STAR= .72014-04
ALPHA OT= .88517-04

1318-88-9,300F,CAP4

| P (PSI) | V (CP) |
|---|---|
| .00000 | .10800+03 |
| .52507+04 | .17407+03 |
| .11578+05 | .27004+03 |
| .20853+05 | .46143+03 |
| .36387+05 | .99582+03 |
| .50774+05 | .16582+04 |
| .72856+05 | .39161+04 |
| .78073+05 | .46666+04 |

ALPHA STAR= .64759-04
ALPHA OT= .10751-03

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1318-88-9,100F,CAP1,6-15-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11104. | .2322+02 | .1642+05 | .3244-01 | .4045+03 | .4898+06 | .3653-01 |
| 100-2 | 11142. | .2654+02 | .1477+05 | .1876-01 | .3237+03 | .3920+06 | .2639-01 |
| 100-3 | 11104. | .2760+02 | .1314+05 | .1485-01 | .3016+03 | .3652+06 | .2243-01 |
| 100-4 | 11142. | .2397+02 | .2019+05 | .3505-01 | .3995+03 | .4839+06 | .3996-01 |
| 100-5 | 11180. | .2411+02 | .2044+05 | .3595-01 | .4069+03 | .4928+06 | .4023-01 |
| 100-6 | 11142. | .2640+02 | .1099+05 | .1039-01 | .2403+03 | .2910+06 | .1968-01 |
| 100-7 | 11104. | .2500+02 | .2479+05 | .5285-01 | .4768+03 | .5702+06 | .5112-01 |
| 100-8 | 11294. | .2408+02 | .2146+05 | .3963-01 | .4268+03 | .5169+06 | .4229-01 |
| 100-9 | 11275. | .1945+02 | .5162+05 | .2292+00 | .8290+03 | .1004+07 | .1259+00 |
| 100-10 | 11256. | .1926+02 | .5571+05 | .2669+00 | .8867+03 | .1074+07 | .1371+00 |
| 100-11 | 11213. | .2017+02 | .5068+05 | .2158+00 | .8340+03 | .1010+07 | .1178+00 |
| 100-12 | 11256. | .1555+02 | .6133+05 | .3235+00 | .9392+03 | .1137+07 | .1569+00 |
| 100-13 | 11255. | .2036+02 | .5060+05 | .2202+00 | .8507+03 | .1030+07 | .1179+00 |
| 100-14 | 11294. | .1377+02 | .5775+05 | .2869+00 | .8949+03 | .1084+07 | .1460+00 |
| 100-15 | 11255. | .2247+02 | .3066+05 | .8083-01 | .5690+03 | .6891+06 | .6474-01 |
| 100-16 | 21547. | .5920+02 | .8488+04 | .6197-02 | .4149+03 | .5024+06 | .6803-02 |
| 100-17 | 21547. | .6091+02 | .7414+04 | .4729-02 | .3729+03 | .4516+06 | .5776-02 |
| 100-18 | 21547. | .6764+02 | .3073+04 | .8123-03 | .1716+03 | .2079+06 | .2156-02 |
| 100-19 | 21547. | .6433+01 | .4878+05 | .2047+00 | .2591+03 | .3138+06 | .3596+00 |
| 100-20 | 21547. | .6217+02 | .7024+04 | .4244-02 | .3606+03 | .4367+06 | .5361-02 |
| 100-21 | 21547. | .5335+02 | .1463+05 | .1842-01 | .6446+03 | .7807+06 | .1302-01 |
| 100-22 | 21547. | .4370+02 | .2780+05 | .6650-01 | .1005+04 | .1217+07 | .3013-01 |
| 100-23 | 21547. | .4215+02 | .3073+05 | .8123-01 | .1070+04 | .1295+07 | .3459-01 |
| 100-24 | 21547. | .5586+02 | .1200+05 | .1239-01 | .5535+03 | .6703+06 | .1019-01 |
| 100-25 | 21547. | .6031+02 | .8488+04 | .6197-02 | .4227+03 | .5119+06 | .6678-02 |
| 100-26 | 21398. | .5822+02 | .9512+04 | .7783-02 | .4573+03 | .5538+06 | .7752-02 |
| 100-27 | 21398. | .5433+02 | .1208+05 | .1239-01 | .5388+03 | .6526+06 | .1047-01 |
| 100-28 | 21393. | .4167+02 | .3512+05 | .1061+00 | .1208+04 | .1464+07 | .3999-01 |
| 100-29 | 21398. | .4107+02 | .3571+05 | .1097+00 | .1211+04 | .1466+07 | .4125-01 |

1318-88-10,CAP4,100F,5-26-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-2 | 5357. | .3407+01 | .6415+04 | .5641-02 | .3724+03 | .2186+05 | .1424+00 |
| 100-3 | 5357. | .3623+01 | .4415+04 | .2671-02 | .2725+03 | .1599+05 | .9214-01 |
| 100-4 | 5357. | .3865+01 | .3725+04 | .1902-02 | .2453+03 | .1440+05 | .7287-01 |
| 100-5 | 5337. | .3420+01 | .5104+04 | .3572-02 | .2974+03 | .1746+05 | .1128+00 |
| 100-6 | 5240. | .3515+01 | .1186+05 | .1930-01 | .7105+03 | .4170+05 | .2552+00 |
| 100-11 | 5357. | .3419+01 | .6760+04 | .6264-02 | .3938+03 | .2311+05 | .1495+00 |
| 100-12 | 11701. | .6121+01 | .2001+04 | .5488-03 | .2087+03 | .1225+05 | .2472-01 |
| 100-15 | 11505. | .6480+01 | .6968+04 | .6655-02 | .7692+03 | .4515+05 | .8130-01 |
| 100-17 | 11583. | .5876+01 | .2982+04 | .1219-02 | .2985+03 | .1752+05 | .3837-01 |
| 100-18 | 11427. | .6939+01 | .8883+04 | .1081-01 | .1050+04 | .6164+05 | .9678-01 |
| 100-19 | 21952. | .1493+02 | .3595+04 | .1772-02 | .9144+03 | .5367+05 | .1821-01 |
| 100-21 | 21198. | .1537+02 | .1612+04 | .3560-03 | .4222+03 | .2478+05 | .7925-02 |
| 100-22 | 21198. | .1461+02 | .3223+04 | .1424-02 | .8021+03 | .4708+05 | .1669-01 |
| 100-23 | 20746. | .1420+02 | .3812+04 | .1992-02 | .9220+03 | .5412+05 | .2030-01 |
| 100-25 | 29791. | .3101+02 | .7380+03 | .7465-04 | .3898+03 | .2288+05 | .1800-02 |
| 100-26 | 29641. | .2970+02 | .1733+04 | .4118-03 | .8771+03 | .5148+05 | .4412-02 |
| 100-27 | 29339. | .2954+02 | .7845+03 | .8437-04 | .3949+03 | .2318+05 | .2008-02 |
| 100-28 | 29339. | .2766+02 | .9439+03 | .1221-03 | .4448+03 | .2611+05 | .2580-02 |
| 100-29 | 29038. | .2936+02 | .1459+04 | .2917-03 | .7297+03 | .4283+05 | .3756-02 |
| 100-30 | 40043. | .6346+02 | .6350+03 | .5527-04 | .6865+03 | .4029+05 | .7566-03 |
| 100-31 | 38837. | .5902+02 | .3776+03 | .1954-04 | .3796+03 | .2228+05 | .4837-03 |
| 100-32 | 38385. | .4727+02 | .3690+03 | .1866-04 | .2972+03 | .1744+05 | .5902-03 |
| 100-33 | 38083. | .5846+02 | .5492+03 | .4134-04 | .5470+03 | .3210+05 | .7103-03 |
| 100-34 | 38083. | .4407+02 | .4290+03 | .2523-04 | .3222+03 | .1891+05 | .7360-03 |
| 100-35 | 50144. | .1212+03 | .1918+03 | .5040-05 | .3959+03 | .2324+05 | .1196-03 |
| 100-36 | 49767. | .1177+03 | .8429+02 | .9738-06 | .1691+03 | .9925+04 | .5413-04 |
| 100-37 | 49691. | .1138+03 | .2348+03 | .7557-05 | .4551+03 | .2671+05 | .1561-03 |
| 100-38 | 49691. | .1111+03 | .3853+03 | .2035-04 | .7294+03 | .4281+05 | .2622-03 |
| 100-39 | 49541. | .1114+03 | .3492+03 | .1671-04 | .6626+03 | .3889+05 | .2371-03 |
| 100-41 | 62506. | .2546+03 | .1138+03 | .1775-05 | .4935+03 | .2897+05 | .3380-04 |
| 100-42 | 62506. | .2681+03 | .1054+03 | .1522-05 | .4813+03 | .2825+05 | .2971-04 |
| 100-43 | 62054. | .2504+03 | .1836+03 | .4622-05 | .7835+03 | .4599+05 | .5544-04 |
| 100-44 | 62204. | .2444+03 | .1144+03 | .1794-05 | .4762+03 | .2795+05 | .3540-04 |
| 100-45 | 61827. | .2456+03 | .1309+03 | .2350-05 | .5479+03 | .3216+05 | .4032-04 |
| 100-46 | 61903. | .2646+03 | .1656+03 | .3758-05 | .7463+03 | .4380+05 | .4732-04 |
| 100-47 | 72305. | .4536+03 | .7275+02 | .7255-06 | .5622+03 | .3300+05 | .1213-04 |
| 100-48 | 72305. | .3931+03 | .8153+02 | .9111-06 | .5460+03 | .3205+05 | .1568-04 |
| 100-49 | 72305. | .4171+03 | .1535+03 | .3231-05 | .1091+04 | .6404+05 | .2783-04 |
| 100-50 | 71853. | .4031+03 | .8489+02 | .9878-06 | .5830+03 | .3422+05 | .1592-04 |
| 100-51 | 72305. | .4468+03 | .1430+03 | .2803-05 | .1089+04 | .6389+05 | .2420-04 |
| 100-52 | 78938. | .5421+03 | .8028+02 | .8833-06 | .7414+03 | .4352+05 | .1120-04 |
| 100-54 | 78637. | .5029+03 | .4014+02 | .2208-06 | .3439+03 | .2019+05 | .6034-05 |
| 100-55 | 78788. | .4992+03 | .8278+02 | .9394-06 | .7041+03 | .4133+05 | .1254-04 |
| 100-56 | 78486. | .6140+03 | .8228+02 | .9280-06 | .8608+03 | .5052+05 | .1013-04 |

FLUID 1318 88 10,CAP 4,210,5 28 71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 421052 | 5257. | .7547+00 | .2968+05 | .1141+00 | .3816+03 | .2240+05 | .2810+01 |
| 421053 | 5257. | .7312+00 | .2986+05 | .1155+00 | .3720+03 | .2183+05 | .2918+01 |
| 421054 | 5257. | .7777+00 | .2914+05 | .1100+00 | .3861+03 | .2266+05 | .2677+01 |
| 421055 | 5265. | .7480+00 | .3719+05 | .1792+00 | .4740+03 | .2782+05 | .3552+01 |
| 421056 | 5265. | .7578+00 | .3909+05 | .1979+00 | .5047+03 | .2963+05 | .3685+01 |
| 421057 | 5265. | .7754+00 | .2932+05 | .1113+00 | .3873+03 | .2273+05 | .2701+01 |
| 421058 | 5265. | .7441+00 | .2769+05 | .9931-01 | .3510+03 | .2060+05 | .2659+01 |
| 421046 | 11737. | .1229+01 | .2063+05 | .5513-01 | .4319+03 | .2535+05 | .1200+01 |
| 421047 | 11737. | .1258+01 | .1864+05 | .4501-01 | .3996+03 | .2345+05 | .1059+01 |
| 421048 | 11737. | .1227+01 | .1918+05 | .4767-01 | .4010+03 | .2354+05 | .1117+01 |
| 421049 | 11660. | .1238+01 | .2479+05 | .7963-01 | .5231+03 | .3070+05 | .1431+01 |
| 421050 | 11660. | .1268+01 | .2063+05 | .5513-01 | .4456+03 | .2615+05 | .1163+01 |
| 421051 | 11737. | .1253+01 | .2317+05 | .6951-01 | .4944+03 | .2902+05 | .1321+01 |
| 421038 | 21125. | .2364+01 | .1009+05 | .1319-01 | .4065+03 | .2386+05 | .3049+00 |
| 421039 | 21051. | .2432+01 | .1224+05 | .1941-01 | .5072+03 | .2977+05 | .3596+00 |
| 421040 | 21051. | .2554+01 | .1100+05 | .1568-01 | .4789+03 | .2811+05 | .3078+00 |
| 421041 | 21051. | .2392+01 | .1133+05 | .1662-01 | .4616+03 | .2709+05 | .3384+00 |
| 421042 | 21051. | .2404+01 | .1432+05 | .2658-01 | .5868+03 | .3444+05 | .4256+00 |
| 421043 | 21051. | .2362+01 | .9245+04 | .1107-01 | .3720+03 | .2184+05 | .2797+00 |
| 421044 | 21051. | .2381+01 | .7691+04 | .7662-02 | .3120+03 | .1831+05 | .2308+00 |
| 421045 | 21051. | .2361+01 | .1112+05 | .1601-01 | .4472+03 | .2625+05 | .3365+00 |
| 42101 | 31469. | .4506+01 | .6209+04 | .4994-02 | .4767+03 | .2798+05 | .9845-01 |
| 42102 | 31323. | .4733+01 | .4291+04 | .2385-02 | .3460+03 | .2031+05 | .6478-01 |
| 42103 | 31323. | .4656+01 | .3905+04 | .1975-02 | .3098+03 | .1818+05 | .5991-01 |
| 42104 | 31469. | .4488+01 | .6205+04 | .4987-02 | .4745+03 | .2785+05 | .9877-01 |
| 42105 | 31469. | .4633+01 | .4446+04 | .2560-02 | .3510+03 | .2060+05 | .6856-01 |
| 42106 | 31542. | .4422+01 | .5606+04 | .4070-02 | .4224+03 | .2479+05 | .9056-01 |
| 42107 | 40521. | .7191+01 | .2969+04 | .1142-02 | .3637+03 | .2135+05 | .2950-01 |
| 42108 | 40521. | .7451+01 | .4098+04 | .2175-02 | .5202+03 | .3054+05 | .3929-01 |
| 42109 | 40448. | .7784+01 | .3905+04 | .1975-02 | .5178+03 | .3039+05 | .3584-01 |
| 421010 | 40448. | .7653+01 | .3711+04 | .1784-02 | .4839+03 | .2840+05 | .3465-01 |
| 421011 | 40375. | .7094+01 | .4485+04 | .2605-02 | .5420+03 | .3181+05 | .4517-01 |
| 421012 | 40375. | .7286+01 | .3518+04 | .1603-02 | .4367+03 | .2563+05 | .3450-01 |
| 421013 | 40229. | .7425+01 | .3634+04 | .1711-02 | .4597+03 | .2698+05 | .3497-01 |
| 421014 | 49982. | .1156+02 | .2088+04 | .5645-03 | .4111+03 | .2413+05 | .1290-01 |
| 421015 | 49894. | .1143+02 | .2552+04 | .8433-03 | .4969+03 | .2917+05 | .1595-01 |
| 421016 | 49894. | .1177+02 | .1675+04 | .3635-03 | .3359+03 | .1971+05 | .1017-01 |
| 421017 | 49880. | .1206+02 | .2603+04 | .8777-03 | .5350+03 | .3140+05 | .1542-01 |
| 421018 | 49865. | .1164+02 | .2945+04 | .1123-02 | .5839+03 | .3427+05 | .1807-01 |
| 421019 | 49836. | .1122+02 | .2799+04 | .1015-02 | .5349+03 | .3140+05 | .1782-01 |
| 421020 | 59210. | .1785+02 | .1939+04 | .4868-03 | .5896+03 | .3461+05 | .7760-02 |
| 421021 | 59210. | .1734+02 | .2274+04 | .6698-03 | .6719+03 | .3944+05 | .9368-02 |
| 421022 | 59210. | .1738+02 | .1370+04 | .2432-03 | .4057+03 | .2381+05 | .5633-02 |
| 421023 | 59136. | .1825+02 | .1735+04 | .3897-03 | .5394+03 | .3166+05 | .6790-02 |
| 421024 | 59136. | .1711+02 | .1254+04 | .2036-03 | .3654+03 | .2145+05 | .5236-02 |
| 421025 | 71620. | .3178+02 | .6487+03 | .5450-04 | .3512+03 | .2061+05 | .1459-02 |
| 421026 | 71474. | .3072+02 | .9074+03 | .1067-03 | .4750+03 | .2788+05 | .2110-02 |
| 421027 | 71474. | .3045+02 | .7799+03 | .7878-04 | .4045+03 | .2374+05 | .1830-02 |
| 421028 | 71474. | .3055+02 | .9949+03 | .1282-03 | .5178+03 | .3039+05 | .2327-02 |
| 421029 | 73104. | .3192+02 | .6487+03 | .5450-04 | .3527+03 | .2070+05 | .1452-02 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 421030 | 73030. | .3326+02 | .6045+03 | .4733-04 | .3425+03 | .2010+05 | .1298-02 |
| 421031 | 73030. | .3259+02 | .5971+03 | .4618-04 | .3315+03 | .1946+05 | .1309-02 |
| 421032 | 78125. | .3855+02 | .5307+03 | .3649-04 | .3486+03 | .2046+05 | .9835-03 |
| 421033 | 78125. | .4017+02 | .4814+03 | .3001-04 | .3294+03 | .1934+05 | .8561-03 |
| 421034 | 78051. | .4021+02 | .6155+03 | .4907-04 | .4217+03 | .2475+05 | .1094-02 |
| 421035 | 78051. | .3960+02 | .5307+03 | .3649-04 | .3580+03 | .2102+05 | .9577-03 |
| 421036 | 78051. | .4014+02 | .6708+03 | .5828-04 | .4588+03 | .2693+05 | .1194-02 |
| 421037 | 78051. | .3866+02 | .6782+03 | .5957-04 | .4467+03 | .2622+05 | .1253-02 |

1318-88-10,CAP. 4, 300 F, 5-29-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5306. | .3509+00 | .4325+05 | .2337+00 | .2586+03 | .1518+05 | .8493+01 |
| 300-2 | 5306. | .3448+00 | .2468+05 | .7605-01 | .1450+03 | .8509+04 | .4930+01 |
| 300-3 | 5306. | .3340+00 | .4131+05 | .2132+00 | .2351+03 | .1380+05 | .8523+01 |
| 300-4 | 5306. | .3383+00 | .3480+05 | .1512+00 | .2005+03 | .1177+05 | .7087+01 |
| 300-1-E | 5424. | .3839+00 | .3771+05 | .1776+00 | .2466+03 | .1448+05 | .6767+01 |
| 300-2-E | 5424. | .3734+00 | .3355+05 | .1406+00 | .2134+03 | .1253+05 | .6190+01 |
| 300-3-E | 5424. | .3768+00 | .3632+05 | .1648+00 | .2332+03 | .1369+05 | .6641+01 |
| 300-4-E | 5424. | .3879+00 | .3078+05 | .1183+00 | .2034+03 | .1194+05 | .5466+01 |
| 300-5 | 11405. | .5902+00 | .2024+05 | .5117-01 | .2035+03 | .1195+05 | .2362+01 |
| 300-6 | 11445. | .5275+00 | .2745+05 | .9411-01 | .2467+03 | .1448+05 | .3585+01 |
| 300-7 | 11405. | .5253+00 | .2301+05 | .6615-01 | .2059+03 | .1209+05 | .3018+01 |
| 300-8 | 11386. | .5438+00 | .2634+05 | .8665-01 | .2440+03 | .1432+05 | .3337+01 |
| 300-9 | 11602. | .5593+00 | .2079+05 | .5401-01 | .1981+03 | .1163+05 | .2562+01 |
| 300-5-E | 11228. | .5361+00 | .3244+05 | .1314+00 | .2963+03 | .1739+05 | .4169+01 |
| 300-6-E | 11209. | .5469+00 | .1774+05 | .3933-01 | .1653+03 | .9705+04 | .2235+01 |
| 300-7-E | 11209. | .5639+00 | .2357+05 | .6937-01 | .2264+03 | .1329+05 | .2879+01 |
| 300-10 | 19691. | .9099+00 | .1023+05 | .1306-01 | .1585+03 | .9306+04 | .7744+00 |
| 300-11 | 19691. | .8931+00 | .1519+05 | .2880-01 | .2311+03 | .1356+05 | .1172+01 |
| 300-12 | 19691. | .8843+00 | .1891+05 | .4464-01 | .2848+03 | .1672+05 | .1473+01 |
| 300-14 | 19691. | .9412+00 | .1356+05 | .2296-01 | .2174+03 | .1276+05 | .9925+00 |
| 300-15 | 20173. | .1046+01 | .1716+05 | .3680-01 | .3059+03 | .1796+05 | .1130+01 |
| 300-10-E | 20173. | .1006+01 | .1716+05 | .3680-01 | .2942+03 | .1727+05 | .1175+01 |
| 300-11-E | 20294. | .9575+00 | .1880+05 | .4414-01 | .3067+03 | .1800+05 | .1353+01 |
| 300-12-E | 20294. | .9502+00 | .1744+05 | .3797-01 | .2823+03 | .1657+05 | .1264+01 |
| 300-13-E | 20294. | .9612+00 | .1716+05 | .3680-01 | .2811+03 | .1650+05 | .1230+01 |
| 300-14-E | 37329. | .2125+01 | .7593+04 | .7201-02 | .2749+03 | .1614+05 | .2461+00 |
| 300-16 | 37329. | .2078+01 | .8755+04 | .9574-02 | .3099+03 | .1819+05 | .2903+00 |
| 300-17 | 37329. | .2097+01 | .1154+05 | .1665-01 | .4124+03 | .2420+05 | .3794+00 |
| 300-18 | 37329. | .2101+01 | .8445+04 | .8908-02 | .3024+03 | .1775+05 | .2769+00 |
| 300-19 | 37329. | .2138+01 | .5966+04 | .4446-02 | .2174+03 | .1276+05 | .1922+00 |
| 300-20 | 37329. | .1986+01 | .7826+04 | .7649-02 | .2648+03 | .1554+05 | .2714+00 |
| 300-21 | 53536. | .4184+01 | .4998+04 | .3119-02 | .3562+03 | .2091+05 | .8229-01 |
| 300-22 | 53536. | .4139+01 | .4959+04 | .3071-02 | .3497+03 | .2053+05 | .8253-01 |
| 300-23 | 53611. | .3866+01 | .5501+04 | .3780-02 | .3624+03 | .2127+05 | .9802-01 |
| 300-24 | 53611. | .4086+01 | .3580+04 | .1600-02 | .2492+03 | .1463+05 | .6036-01 |
| 300-25 | 53611. | .4186+01 | .4571+04 | .2610-02 | .3260+03 | .1913+05 | .7524-01 |
| 300-26 | 53611. | .4228+01 | .6353+04 | .5042-02 | .4577+03 | .2686+05 | .1035+00 |
| 300-27 | 53611. | .4266+01 | .4649+04 | .2699-02 | .3379+03 | .1983+05 | .7507-01 |
| 300-34 | 70044. | .7458+01 | .2188+04 | .5980-03 | .2780+03 | .1632+05 | .2021-01 |
| 300-35 | 69742. | .7452+01 | .2283+04 | .6507-03 | .2898+03 | .1701+05 | .2110-01 |
| 300-36 | 69742. | .7421+01 | .2889+04 | .1042-02 | .3653+03 | .2144+05 | .2682-01 |
| 300-37 | 69742. | .7568+01 | .3060+04 | .1170-02 | .3946+03 | .2316+05 | .2786-01 |
| 300-38 | 69742. | .7603+01 | .2631+04 | .8649-03 | .3409+03 | .2001+05 | .2384-01 |
| 300-39 | 69742. | .7648+01 | .2623+04 | .8592-03 | .3418+03 | .2006+05 | .2363-01 |
| 300-28 | 79541. | .9663+01 | .1888+04 | .4451-03 | .3108+03 | .1824+05 | .1346-01 |
| 300-29 | 79541. | .9874+01 | .1688+04 | .3557-03 | .2839+03 | .1666+05 | .1177-01 |
| 300-30 | 79692. | .1017+02 | .1688+04 | .3557-03 | .2925+03 | .1717+05 | .1143-01 |
| 300-31 | 79692. | .1013+02 | .1802+04 | .4056-03 | .3109+03 | .1825+05 | .1226-01 |
| 300-32 | 79541. | .1029+02 | .2117+04 | .5595-03 | .3710+03 | .2178+05 | .1417-01 |
| 300-33 | 79692. | .1045+02 | .1974+04 | .4865-03 | .3513+03 | .2062+05 | .1301-01 |

************************************************AVERAGED DATA POINTS*********

1318-88-10,CAP4,100F,5-26-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .21400+03 |
| .53342+04 | .35414+03 |
| .11554+05 | .63542+03 |
| .21274+05 | .14776+04 |
| .29430+05 | .29455+04 |
| .38435+05 | .54916+04 |
| .49767+05 | .11503+05 |
| .62167+05 | .25460+05 |
| .72215+05 | .42274+05 |
| .78712+05 | .53957+05 |

ALPHA STAR= .89209-04
ALPHA OT= .99015-04

FLUID 1318 88 10,CAP 4,210,5 28 71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .47000+02 |
| .52616+04 | .75556+02 |
| .11712+05 | .12454+03 |
| .21060+05 | .24063+03 |
| .31432+05 | .45733+03 |
| .40417+05 | .74119+03 |
| .49892+05 | .11613+04 |
| .59180+05 | .17586+04 |
| .72172+05 | .31609+04 |
| .78076+05 | .39556+04 |

ALPHA STAR= .74251-04
ALPHA OT= .10068-03

1318-88-10,CAP. 4, 300 F, 5-29-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .21650+02 |
| .53653+04 | .36124+02 |
| .11361+05 | .54913+02 |
| .19999+05 | .94995+02 |
| .37329+05 | .20876+03 |
| .53590+05 | .41365+03 |
| .69792+05 | .75251+03 |
| .79617+05 | .10096+04 |

ALPHA STAR= .66859-04
ALPHA OT= .11642-03

02

1318-88-10+100F+CAP1+

| RUN | P3 | VISCP | WSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11445. | .5938+01 | .6867+05 | .4222+00 | .3376+03 | .4089+06 | .5696+00 |
| 100-2 | 11523. | .5906+01 | .6092+05 | .3304+00 | .2972+03 | .3599+06 | .5064+00 |
| 100-3 | 11438. | .5546+01 | .8264+05 | .6090+00 | .3784+03 | .4582+06 | .7319+00 |
| 100-4 | 11523. | .5614+01 | .7840+05 | .5472+00 | .3637+03 | .4405+06 | .6853+00 |
| 100-5 | 11523. | .4950+01 | .1950+06 | .3385+01 | .7971+03 | .9653+06 | .1935+01 |
| 100-6 | 11523. | .4920+01 | .2020+06 | .3632+01 | .8205+03 | .9937+06 | .2016+01 |
| 100-7 | 11523. | .4366+01 | .2670+06 | .6345+01 | .9670+03 | .1171+07 | .2989+01 |
| 100-8 | 11523. | .4652+01 | .2298+06 | .4702+01 | .8829+03 | .1069+07 | .2426+01 |
| 100-9 | 11553. | .4420+01 | .3082+06 | .8487+01 | .1027+04 | .1244+07 | .3764+01 |
| 100-10 | 11759. | .4940+01 | .1764+06 | .2771+01 | .7197+03 | .8716+06 | .1754+01 |
| 100-11 | 11445. | .4483+01 | .1904+06 | .3226+01 | .7676+03 | .9296+06 | .1914+01 |
| 100-12 | 11484. | .3649+01 | .3153+06 | .8848+01 | .9501+03 | .1151+07 | .4242+01 |
| 100-13 | 11434. | .4572+01 | .2229+06 | .4422+01 | .8414+03 | .1019+07 | .2394+01 |
| 100-14 | 11464. | .4643+01 | .2693+06 | .6456+01 | .1034+04 | .1252+07 | .2845+01 |
| 100-15 | 11445. | .4735+01 | .2438+06 | .5290+01 | .9531+03 | .1154+07 | .2528+01 |
| 100-16 | 11523. | .5072+01 | .1973+06 | .3467+01 | .8264+03 | .1001+07 | .1911+01 |
| 100-17 | 15242. | .4650+01 | .2043+06 | .3716+01 | .7844+03 | .9499+06 | .2158+01 |
| 100-18 | 11287. | .4382+01 | .2577+06 | .5912+01 | .9324+03 | .1129+07 | .2888+01 |
| 100-19 | 11249. | .3686+01 | .2948+06 | .7739+01 | .9461+03 | .1146+07 | .3725+01 |
| 100-20 | 21094. | .1203+02 | .3917+05 | .1366+00 | .3907+03 | .4731+06 | .1593+00 |
| 100-21 | 21171. | .1176+02 | .4237+05 | .1598+00 | .4093+03 | .4957+06 | .1778+00 |
| 100-22 | 21171. | .1306+02 | .3251+05 | .9409-01 | .3505+03 | .4245+06 | .1223+00 |
| 100-23 | 21249. | .1242+02 | .4637+05 | .1914+00 | .4757+03 | .5761+06 | .1832+00 |
| 100-24 | 21249. | .1312+02 | .4344+05 | .1680+00 | .4706+03 | .5699+06 | .1626+00 |
| 100-25 | 2148[illegible]. | .1252+02 | .4690+05 | .1953+00 | .4847+03 | .5870+06 | .1840+00 |
| 100-26 | 21094. | .1114+02 | .7229+05 | .4652+00 | .6648+03 | .8050+06 | .3187+00 |
| 100-27 | 20971. | .1044+02 | .1074+06 | .1027+01 | .9261+03 | .1122+07 | .5052+00 |
| 100-28 | 21171. | .1050+02 | .1181+06 | .1242+01 | .1024+04 | .1240+07 | .5526+00 |
| 100-29 | 21094. | .1116+02 | .1048+06 | .9045+00 | .9276+03 | .1123+07 | .4441+00 |
| 100-30 | 20940. | .1096+02 | .8400+05 | .6281+00 | .7602+03 | .9207+06 | .3763+00 |
| 100-31 | 21403. | .1289+02 | .4797+05 | .2048+00 | .5102+03 | .6179+06 | .1828+00 |
| 100-32 | 21326. | .1229+02 | .5623+05 | .2814+00 | .5705+03 | .6909+06 | .2247+00 |

1318-88-11,CAP4,100F,7-21-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5241. | .3739+00 | .4752+05 | .3194+00 | .3027+03 | .1777+05 | .9916+01 |
| 100-2 | 5241. | .3638+00 | .4342+05 | .2667+00 | .2691+03 | .1580+05 | .9313+01 |
| 100-3 | 5241. | .3750+00 | .3414+05 | .1648+00 | .2181+03 | .1280+05 | .7102+01 |
| 100-4 | 5241. | .3713+00 | .4916+05 | .3418+00 | .3110+03 | .1825+05 | .1033+02 |
| 100-5 | 5241. | .3830+00 | .3714+05 | .1951+00 | .2424+03 | .1422+05 | .7567+01 |
| 100-6 | 5241. | .3850+00 | .5899+05 | .4922+00 | .3870+03 | .2271+05 | .1195+02 |
| 100-7 | 11539. | .5531+00 | .3427+05 | .1662+00 | .3230+03 | .1896+05 | .4835+01 |
| 100-8 | 11539. | .5749+00 | .3004+05 | .1277+00 | .2942+03 | .1727+05 | .4077+01 |
| 100-9 | 11539. | .5860+00 | .2622+05 | .9723-01 | .2618+03 | .1536+05 | .3491+01 |
| 100-10 | 11539. | .5763+00 | .5325+05 | .4012+00 | .5229+03 | .3069+05 | .7210+01 |
| 100-11 | 11539. | .5617+00 | .2540+05 | .9125-01 | .2430+03 | .1427+05 | .3528+01 |
| 100-12 | 11539. | .5538+00 | .8497+05 | .1021+01 | .8018+03 | .4706+05 | .1197+02 |
| 100-13 | 11539. | .5787+00 | .1065+06 | .1605+01 | .1050+04 | .6164+05 | .1436+02 |
| 100-14 | 11539. | .5643+00 | .9575+05 | .1297+01 | .9206+03 | .5403+05 | .1324+02 |
| 100-15 | 11539. | .5704+00 | .1077+06 | .1641+01 | .1047+04 | .6144+05 | .1473+02 |
| 100-16 | 11539. | .5099+00 | .1293+06 | .2363+01 | .1123+04 | .6590+05 | .1978+02 |
| 100-17 | 11539. | .5486+00 | .6828+04 | .6594-02 | .6381+02 | .3745+04 | .9711+00 |
| 100-18 | 11539. | .5650+00 | .4453+04 | .2805-02 | .4287+02 | .2516+04 | .6149+00 |
| 100-19 | 11539. | .5754+00 | .3029+04 | .1298-02 | .2969+02 | .1743+04 | .4108+00 |
| 100-20 | 11539. | .5583+00 | .8466+04 | .1014-01 | .8053+02 | .4727+04 | .1183+01 |
| 100-21 | 11539. | .5772+00 | .1398+05 | .2765-01 | .1375+03 | .8069+04 | .1890+01 |
| 100-22 | 19125. | .9403+00 | .1156+05 | .1889-01 | .1851+03 | .1087+05 | .9591+00 |
| 100-23 | 19125. | .9703+00 | .2059+05 | .5995-01 | .3403+03 | .1997+05 | .1655+01 |
| 100-24 | 19275. | .9640+00 | .3765+05 | .2005+00 | .6184+03 | .3629+05 | .3048+01 |
| 100-25 | 19275. | .9116+00 | .1950+05 | .5380-01 | .3029+03 | .1778+05 | .1669+01 |
| 100-26 | 19275. | .9525+00 | .2655+05 | .9968-01 | .4308+03 | .2528+05 | .2175+01 |
| 100-27 | 19275. | .1000+01 | .6210+05 | .5455+00 | .1058+04 | .6210+05 | .4845+01 |
| 100-28 | 19275. | .9421+00 | .5434+05 | .4176+00 | .8721+03 | .5119+05 | .4500+01 |
| 100-29 | 19275. | .1008+01 | .7025+05 | .6981+00 | .1207+04 | .7083+05 | .5437+01 |
| 100-30 | 19275. | .9481+00 | .6210+05 | .5455+00 | .1003+04 | .5888+05 | .5110+01 |
| 100-31 | 28418. | .1553+01 | .1379+05 | .2690-01 | .3647+03 | .2141+05 | .6930+00 |
| 100-32 | 28418. | .1604+01 | .1687+05 | .4026-01 | .4611+03 | .2707+05 | .8205+00 |
| 100-33 | 28418. | .1518+01 | .1279+05 | .2313-01 | .3307+03 | .1941+05 | .6574+00 |
| 100-34 | 28418. | .1585+01 | .2126+05 | .6394-01 | .5741+03 | .3370+05 | .1047+01 |
| 100-35 | 28418. | .1598+01 | .1926+05 | .5246-01 | .5243+03 | .3077+05 | .9404+00 |
| 100-36 | 38760. | .2596+01 | .7472+04 | .7898-02 | .3304+03 | .1940+05 | .2246+00 |
| 100-37 | 38760. | .2741+01 | .1256+05 | .2230-01 | .5863+03 | .3441+05 | .3575+00 |
| 100-38 | 38760. | .2657+01 | .8782+04 | .1091-01 | .3975+03 | .2333+05 | .2579+00 |
| 100-39 | 38760. | .2766+01 | .1032+05 | .1507-01 | .4865+03 | .2856+05 | .2911+00 |
| 100-40 | 38760. | .2689+01 | .5777+04 | .4722-02 | .2647+03 | .1554+05 | .1676+00 |
| 100-41 | 51201. | .5228+01 | .4180+04 | .2472-02 | .3724+03 | .2186+05 | .6239-01 |
| 100-42 | 51201. | .4972+01 | .6015+04 | .5117-02 | .5095+03 | .2990+05 | .9439-01 |
| 100-43 | 51201. | .4906+01 | .4180+04 | .2472-02 | .3494+03 | .2051+05 | .6649-01 |
| 100-44 | 51201. | .4896+01 | .2261+04 | .7230-03 | .1886+03 | .1107+05 | .3603-01 |
| 100-45 | 51201. | .5028+01 | .5545+04 | .4350-02 | .4751+03 | .2788+05 | .8605-01 |
| 100-46 | 54768. | .5594+01 | .3540+04 | .1773-02 | .3374+03 | .1981+05 | .4938-01 |
| 100-47 | 54768. | .5760+01 | .2730+04 | .1054-02 | .2679+03 | .1573+05 | .3698-01 |
| 100-48 | 54768. | .5903+01 | .3285+04 | .1526-02 | .3303+03 | .1939+05 | .4341-01 |
| 100-49 | 54768. | .5548+01 | .6100+04 | .5263-02 | .5766+03 | .3384+05 | .8579-01 |
| 100-50 | 54768. | .5798+01 | .4564+04 | .2947-02 | .4509+03 | .2647+05 | .6142-01 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100-51 | 69337. | .1157+02 | .1592+04 | .3587-03 | .3140+03 | .1843+05 | .1074-01 |
| 100-52 | 69337. | .1214+02 | .2104+04 | .6264-03 | .4352+03 | .2555+05 | .1353-01 |
| 100-53 | 69337. | .1245+02 | .1621+04 | .3717-03 | .3436+03 | .2018+05 | .1016-01 |
| 100-54 | 69337. | .1298+02 | .1408+04 | .2803-03 | .3114+03 | .1828+05 | .8459-02 |
| 100-55 | 69337. | .1227+02 | .1507+04 | .3213-03 | .3151+03 | .1849+05 | .9583-02 |
| 100-56 | 76981. | .1714+02 | .1564+04 | .3460-03 | .4568+03 | .2681+05 | .7119-02 |
| 100-57 | 76981. | .1704+02 | .2161+04 | .6607-03 | .6275+03 | .3683+05 | .9895-02 |
| 100-58 | 76981. | .1891+02 | .1607+04 | .3652-03 | .5176+03 | .3038+05 | .6630-02 |
| 100-59 | 76981. | .1881+02 | .1465+04 | .3034-03 | .4693+03 | .2754+05 | .6076-02 |
| 100-60 | 76981. | .1837+02 | .1521+04 | .3274-03 | .4761+03 | .2794+05 | .6463-02 |

1318-88-11,CAP4,210F,7-21-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-1 | 5303. | .1950+00 | .5314+05 | .3733+00 | .1765+03 | .1036+05 | .1987+02 |
| 210-2 | 5303. | .2077+00 | .4831+05 | .3085+00 | .1709+03 | .1003+05 | .1696+02 |
| 210-3 | 5303. | .2413+00 | .5974+05 | .4718+00 | .2456+03 | .1442+05 | .1805+02 |
| 210-4 | 5303. | .2167+00 | .1175+06 | .1827+01 | .4340+03 | .2547+05 | .3955+02 |
| 210-5 | 5303. | .2043+00 | .8051+05 | .8570+00 | .2802+03 | .1645+05 | .2874+02 |
| 210-6 | 11451. | .3160+00 | .4493+05 | .2668+00 | .2419+03 | .1420+05 | .1037+02 |
| 210-7 | 11451. | .3069+00 | .6200+05 | .5081+00 | .3242+03 | .1903+05 | .1473+02 |
| 210-8 | 11451. | .2968+00 | .3035+05 | .1218+00 | .1535+03 | .9008+04 | .7459+01 |
| 210-9 | 11451. | .3111+00 | .3905+05 | .2016+00 | .2070+03 | .1215+05 | .9153+01 |
| 210-10 | 11451. | .2872+00 | .9017+05 | .1075+01 | .4413+03 | .2590+05 | .2289+02 |
| 210-11 | 18635. | .4699+00 | .2357+05 | .7342-01 | .1887+03 | .1107+05 | .3657+01 |
| 210-12 | 18635. | .4375+00 | .4890+05 | .3162+00 | .3645+03 | .2139+05 | .8152+01 |
| 210-13 | 18635. | .5019+00 | .4141+05 | .2267+00 | .3541+03 | .2078+05 | .6017+01 |
| 210-14 | 18635. | .4632+00 | .3828+05 | .1937+00 | .3021+03 | .1773+05 | .6026+01 |
| 210-15 | 18635. | .4762+00 | .2615+05 | .9044-01 | .2122+03 | .1246+05 | .4005+01 |
| 210-16 | 35445. | .9746+00 | .1785+05 | .4210-01 | .2963+03 | .1739+05 | .1335+01 |
| 210-17 | 35445. | .9336+00 | .2016+05 | .5374-01 | .3207+03 | .1882+05 | .1575+01 |
| 210-18 | 35445. | .1005+01 | .2234+05 | .6598-01 | .3824+03 | .2244+05 | .1622+01 |
| 210-19 | 35445. | .9690+00 | .2724+05 | .9813-01 | .4498+03 | .2640+05 | .2050+01 |
| 210-20 | 35445. | .9641+00 | .1894+05 | .4740-01 | .3110+03 | .1826+05 | .1432+01 |
| 210-21 | 49239. | .1626+01 | .7629+04 | .7693-02 | .2113+03 | .1240+05 | .3421+00 |
| 210-22 | 49239. | .1657+01 | .9445+04 | .1179-01 | .2667+03 | .1565+05 | .4155+00 |
| 210-23 | 49239. | .1670+01 | .1126+05 | .1677-01 | .3203+03 | .1880+05 | .4918+00 |
| 210-24 | 49239. | .1481+01 | .8718+04 | .1005-01 | .2200+03 | .1291+05 | .4293+00 |
| 210-25 | 49239. | .1626+01 | .1353+05 | .2421-01 | .3749+03 | .2200+05 | .6068+00 |
| 210-26 | 67104. | .3065+01 | .3616+04 | .1728-02 | .1888+03 | .1108+05 | .8602-01 |
| 210-27 | 67104. | .3148+01 | .5269+04 | .3670-02 | .2826+03 | .1659+05 | .1221+00 |
| 210-28 | 67104. | .2650+01 | .5475+04 | .3963-02 | .2472+03 | .1451+05 | .1507+00 |
| 210-29 | 67104. | .2967+01 | .4132+04 | .2257-02 | .2089+03 | .1226+05 | .1016+00 |
| 210-30 | 67104. | .2868+01 | .5579+04 | .4114-02 | .2726+03 | .1600+05 | .1418+00 |
| 210-31 | 79240. | .4361+01 | .3926+04 | .2037-02 | .2916+03 | .1712+05 | .6565-01 |
| 210-32 | 79240. | .4387+01 | .4391+04 | .2548-02 | .3281+03 | .1926+05 | .7299-01 |
| 210-33 | 79240. | .4300+01 | .5475+04 | .3963-02 | .4011+03 | .2355+05 | .9285-01 |
| 210-34 | 79240. | .4455+01 | .3667+04 | .1778-02 | .2784+03 | .1634+05 | .6003-01 |
| 210-35 | 79240. | .4585+01 | .3203+04 | .1356-02 | .2502+03 | .1468+05 | .5094-01 |

1318-88-11,CAP4,300F,7-21-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5306. | .1441+00 | .9801+05 | .1181+01 | .2407+03 | .1413+05 | .4611+02 |
| 300-2 | 5306. | .1419+00 | .1077+06 | .1427+01 | .2604+03 | .1528+05 | .5150+02 |
| 300-3 | 5306. | .1447+00 | .1717+06 | .3626+01 | .4234+03 | .2485+05 | .8048+02 |
| 300-4 | 5306. | .1424+00 | .6318+05 | .4908+00 | .1532+03 | .8994+04 | .3010+02 |
| 300-5 | 5306. | .1438+00 | .9477+05 | .1104+01 | .2323+03 | .1363+05 | .4469+02 |
| 300-6 | 5306. | .1412+00 | .9396+05 | .1086+01 | .2260+03 | .1327+05 | .4514+02 |
| 300-7 | 12074. | .2067+00 | .5265+05 | .3409+00 | .1854+03 | .1088+05 | .1728+02 |
| 300-8 | 12074. | .2024+00 | .5022+05 | .3101+00 | .1732+03 | .1017+05 | .1683+02 |
| 300-9 | 12074. | .2184+00 | .6723+05 | .5558+00 | .2501+03 | .1468+05 | .2088+02 |
| 300-10 | 12074. | .2197+00 | .7047+05 | .6106+00 | .2638+03 | .1549+05 | .2175+02 |
| 300-11 | 12074. | .2062+00 | .1118+06 | .1536+01 | .3928+03 | .2305+05 | .3676+02 |
| 300-12 | 20384. | .3449+00 | .2839+05 | .9911-01 | .1668+03 | .9793+04 | .5583+01 |
| 300-14 | 20384. | .3408+00 | .4851+05 | .2894+00 | .2817+03 | .1654+05 | .9653+01 |
| 300-15 | 20384. | .3536+00 | .4907+05 | .2960+00 | .2956+03 | .1735+05 | .9410+01 |
| 300-16 | 20384. | .3513+00 | .3060+05 | .1151+00 | .1831+03 | .1075+05 | .5908+01 |
| 300-17 | 20384. | .3766+00 | .4548+05 | .2543+00 | .2918+03 | .1713+05 | .8191+01 |
| 300-18 | 35027. | .6110+00 | .2867+05 | .1010+00 | .2984+03 | .1752+05 | .3182+01 |
| 300-19 | 35027. | .6463+00 | .2315+05 | .6592-01 | .2550+03 | .1497+05 | .2430+01 |
| 300-20 | 34997. | .6256+00 | .1847+05 | .4194-01 | .1968+03 | .1155+05 | .2002+01 |
| 300-21 | 34997. | .6303+00 | .1930+05 | .4578-01 | .2072+03 | .1216+05 | .2076+01 |
| 300-22 | 34997. | .6423+00 | .1930+05 | .4578-01 | .2112+03 | .1239+05 | .2037+01 |
| 300-23 | 52034. | .9937+00 | .1139+05 | .1596-01 | .1929+03 | .1132+05 | .7776+00 |
| 300-24 | 52034. | .9984+00 | .1139+05 | .1596-01 | .1938+03 | .1137+05 | .7740+00 |
| 300-25 | 52034. | .1059+01 | .1847+05 | .4194-01 | .3333+03 | .1956+05 | .1183+01 |
| 300-26 | 51806. | .1104+01 | .1213+05 | .1809-01 | .2282+03 | .1339+05 | .7449+00 |
| 300-27 | 51806. | .1060+01 | .2021+05 | .5024-01 | .3652+03 | .2144+05 | .1293+01 |
| 300-28 | 68736. | .1623+01 | .7351+04 | .6643-02 | .2032+03 | .1193+05 | .3073+00 |
| 300-29 | 68736. | .1713+01 | .7535+04 | .6980-02 | .2199+03 | .1291+05 | .2983+00 |
| 300-30 | 68736. | .1669+01 | .8086+04 | .8039-02 | .2300+03 | .1350+05 | .3285+00 |
| 300-31 | 68736. | .1693+01 | .7351+04 | .6643-02 | .2120+03 | .1245+05 | .2945+00 |
| 300-32 | 68736. | .1618+01 | .6340+04 | .4942-02 | .1748+03 | .1026+05 | .2657+00 |
| 300-33 | 78193. | .2464+01 | .5958+04 | .4364-02 | .2501+03 | .1468+05 | .1640+00 |
| 300-34 | 78193. | .2196+01 | .7839+04 | .7556-02 | .2933+03 | .1721+05 | .2421+00 |
| 300-35 | 78193. | .2322+01 | .6794+04 | .5675-02 | .2688+03 | .1578+05 | .1984+00 |
| 300-36 | 78193. | .2289+01 | .5853+04 | .4212-02 | .2282+03 | .1340+05 | .1734+00 |
| 300-13 | 78193. | .2304+01 | .6141+04 | .4636-02 | .2410+03 | .1415+05 | .1808+00 |

**************************************************AVERAGED DATA POINTS******

1318-88-11,CAP4,100F,7-21-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .26200+02 |
| .52405+04 | .37535+02 |
| .11539+05 | .56357+02 |
| .19242+05 | .95967+02 |
| .28418+05 | .15715+03 |
| .38760+05 | .26897+03 |
| .52984+05 | .53634+03 |
| .69337+05 | .12284+04 |
| .76981+05 | .18054+04 |

ALPHA STAR= .62775-04
ALPHA OT= .72195-04

1318-88-11,CAP4,210F,7-21-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .11550+02 |
| .53032+04 | .21300+02 |
| .11451+05 | .30362+02 |
| .18635+05 | .46973+02 |
| .35445+05 | .96919+02 |
| .49239+05 | .16120+03 |
| .67104+05 | .29395+03 |
| .79240+05 | .44176+03 |

ALPHA STAR= .67474-04
ALPHA OT= .17741-03

1318-88-11,CAP4,300F,7-21-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .73100+01 |
| .53062+04 | .14302+02 |
| .12074+05 | .21068+02 |
| .20384+05 | .35345+02 |
| .35009+05 | .63111+02 |
| .51943+05 | .10432+03 |
| .68736+05 | .16632+03 |
| .78193+05 | .23149+03 |

ALPHA STAR= .70037-04
ALPHA OT= .20545-03

(i) 2

1318-88-11,CAP1,100F,7-19-71

| RUN | P3 | WISEP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5355. | [illegible] | .1774+06 | .2899+01 | [illegible] | .7997+05 | .1993+02 |
| 100-2 | 5355. | .3711+00 | .4633+06 | .1972+02 | .1420+03 | .1719+06 | .6327+02 |
| 100-3 | 5355. | .3620+00 | .5749+06 | .3037+02 | .1722+03 | .2086+06 | .8031+02 |
| 100-4 | 11516. | .5455+00 | .3830+06 | .1348+02 | .1725+03 | .2089+06 | .3558+02 |
| 100-5 | 11516. | [illegible] | .4037+06 | .1497+02 | .2011+03 | .2436+06 | .3390+02 |
| 100-6 | 11516. | .5519+00 | .6743+06 | .4177+02 | .3073+03 | .3722+06 | .6191+02 |
| 100-7 | 11516. | .4925+00 | .9725+06 | .3698+02 | .3955+03 | .4790+06 | .1001+03 |
| 100-8 | 11516. | .5454+00 | .6239+06 | .3575+02 | .2810+03 | .3403+06 | .5796+02 |
| 100-9 | 11516. | .5421+00 | .6257+06 | .6263+02 | .3696+03 | .4476+06 | .7718+02 |
| 100-10 | 11516. | .6310+00 | .8257+06 | .6263+02 | .4302+03 | .5210+06 | .6631+02 |
| 100-11 | 11516. | .4666+00 | .1296+07 | .1543+03 | .4993+03 | .6046+06 | .1407+03 |
| 100-12 | 11516. | .4872+00 | .1300+07 | .1554+03 | .5232+03 | .6336+06 | .1353+03 |
| 100-13 | 11516. | .4947+00 | .9335+06 | .9005+02 | .3814+03 | .4618+06 | .9561+02 |
| 100-14 | 11536. | .6140+00 | .2317+06 | .4930+01 | .1176+03 | .1425+06 | .1909+02 |
| 100-15 | 11536. | .5822+00 | .3762+06 | .1300+02 | .1808+03 | .2190+06 | .3274+02 |
| 100-16 | 11536. | .6363+00 | .1697+06 | .2646+01 | .8918+02 | .1080+06 | .1352+02 |
| 100-17 | 11536. | .5519+00 | .3154+06 | .9137+01 | .1437+03 | .1741+06 | .2896+02 |
| 100-18 | 11536. | .5551+00 | .1116+06 | .1145+01 | .5116+02 | .6196+05 | .1019+02 |
| 100-19 | 11536. | .6393+00 | .1300+06 | .1552+01 | .6539+02 | .7919+05 | .1001+02 |
| 100-20 | 11536. | .6253+00 | .1606+06 | .2368+01 | .8263+02 | .1001+06 | .1305+02 |
| 100-21 | 11536. | .3770+00 | .1055+06 | .1023+01 | .3284+02 | .3978+05 | .1418+02 |
| 100-22 | 20897. | .1023+01 | .1962+06 | .3536+01 | .1665+03 | .2017+06 | .9670+01 |
| 100-23 | 20897. | .1019+01 | .2966+06 | .8080+01 | .2496+03 | .3023+06 | .1474+02 |
| 100-24 | 20897. | .1107+01 | .2669+06 | .6544+01 | .2440+03 | .2955+06 | .1222+02 |
| 100-25 | 20897. | .1093+01 | .2167+06 | .4315+01 | .1956+03 | .2369+06 | .1005+02 |
| 100-26 | 20897. | .9870+00 | .5076+06 | .2367+02 | .4137+03 | .5010+06 | .2606+02 |
| 100-27 | 20897. | .9538+00 | .7391+06 | .5019+02 | .5821+03 | .7050+06 | .3927+02 |
| 100-28 | 20897. | .1033+01 | .6844+06 | .4303+02 | .5866+03 | .7103+06 | .3341+02 |
| 100-29 | 20897. | .1042+01 | .6387+06 | .3743+02 | .5495+03 | .6655+06 | .3107+02 |
| 100-30 | 20897. | .9151+00 | .7300+06 | .4896+02 | .5534+03 | .6702+06 | .4029+02 |
| 100-31 | 20897. | .1153+01 | .9429+05 | .8162+00 | .8977+02 | .1087+06 | .4144+01 |
| 100-32 | 20897. | .1133+01 | .1316+06 | .1590+01 | .1230+03 | .1490+06 | .5886+01 |
| 100-33 | 20897. | .1144+01 | .1749+06 | .2810+01 | .1657+03 | .2007+06 | .7722+01 |
| 100-34 | 20897. | .1115+01 | .1186+06 | .1293+01 | .1092+03 | .1322+06 | .5392+01 |
| 100-35 | 20897. | .9628+00 | .4015+06 | .1481+02 | .3192+03 | .3866+06 | .2113+02 |
| 100-36 | 20897. | .1112+01 | .4410+05 | .1787+00 | .4049+02 | .4903+05 | .2010+01 |
| 100-37 | 20897. | .1162+01 | .7452+05 | .5102+00 | .7271+02 | .8806+05 | .3196+01 |
| 100-38 | 20897. | .1107+01 | .9657+05 | .8568+00 | .8829+02 | .1069+06 | .4420+01 |
| 100-39 | 20897. | .1261+01 | .1845+05 | .3128-01 | .1921+02 | .2327+05 | .7416+00 |
| 100-40 | 20897. | .1057+01 | .5374+05 | .2653+00 | .4692+02 | .5682+05 | .2575+01 |

DC200-20C5,CAP4,100F,3-23-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| DC01 | 5432. | .7502+00 | .2398+05 | .8678-01 | .3065+03 | .1799+05 | .2661+01 |
| DC02 | 5355. | .7395+00 | .1628+05 | .4003-01 | .2052+03 | .1204+05 | .1833+01 |
| DC03 | 5355. | .6985+00 | .1748+05 | .4614-01 | .2080+03 | .1221+05 | .2084+01 |
| DC04 | 5355. | .7046+00 | .1945+05 | .5709-01 | .2335+03 | .1370+05 | .2298+01 |
| DC05 | 5355. | .7301+00 | .2781+05 | .1168+00 | .3460+03 | .2031+05 | .3172+01 |
| DC06 | 5355. | .7415+00 | .2382+05 | .8563-01 | .3009+03 | .1766+05 | .2674+01 |
| DC07 | 5355. | .6832+00 | .2270+05 | .7777-01 | .2642+03 | .1551+05 | .2766+01 |
| DC08 | 11186. | .1272+01 | .9391+04 | .1331-01 | .2034+03 | .1194+05 | .6149+00 |
| DC09 | 11147. | .1144+01 | .1199+05 | .2170-01 | .2336+03 | .1371+05 | .8728+00 |
| DC10 | 11186. | .1236+01 | .1658+05 | .4152-01 | .3493+03 | .2050+05 | .1117+01 |
| DC11 | 11186. | .1211+01 | .1449+05 | .3168-01 | .2090+03 | .1755+05 | .9957+00 |
| DC12 | 11225. | .1208+01 | .4636+05 | .3244+00 | .9543+03 | .5601+05 | .3194+01 |
| DC13 | 11225. | .1252+01 | .5275+05 | .4200+00 | .1125+04 | .6606+05 | .3507+01 |
| DC14 | 11186. | .1386+01 | .5874+05 | .5209+00 | .1387+04 | .8140+05 | .3530+01 |
| DC15 | 11186. | .1196+01 | .6374+05 | .6133+00 | .1299+04 | .7622+05 | .4436+01 |
| DC16 | 11225. | .1128+01 | .6494+05 | .6366+00 | .1248+04 | .7324+05 | .4794+01 |
| DC17 | 19907. | .2573+01 | .6591+04 | .6558-02 | .2889+03 | .1696+05 | .2133+00 |
| DC18 | 19758. | .2526+01 | .6314+04 | .6017-02 | .2717+03 | .1595+05 | .2081+00 |
| DC19 | 20056. | .2542+01 | .6787+04 | .6954-02 | .2939+03 | .1725+05 | .2223+00 |
| DC20 | 19758. | .2442+01 | .1247+05 | .2347-01 | .5187+03 | .3045+05 | .4252+00 |
| DC21 | 19907. | .2517+01 | .1578+05 | .3761-01 | .6769+03 | .3973+05 | .5222+00 |
| DC22 | 19907. | .2669+01 | .1179+05 | .2097-01 | .5359+03 | .3146+05 | .3677+00 |
| DC23 | 19907. | .2576+01 | .1300+05 | .2549-01 | .5704+03 | .3348+05 | .4200+00 |
| DC24 | 19758. | .2336+01 | .2370+05 | .8482-01 | .9433+03 | .5537+05 | .8450+00 |
| DC25 | 19907. | .2421+01 | .2814+05 | .1195+00 | .1161+04 | .6813+05 | .9678+00 |
| DC26 | 19907. | .2448+01 | .2053+05 | .6365-01 | .8566+03 | .5028+05 | .6983+00 |
| DC27 | 29445. | .5311+01 | .3630+04 | .1989-02 | .3285+03 | .1928+05 | .5692-01 |
| DC28 | 29445. | .5338+01 | .4183+04 | .2641-02 | .3804+03 | .2233+05 | .6525-01 |
| DC29 | 29445. | .5200+01 | .5130+04 | .3972-02 | .4545+03 | .2668+05 | .8213-01 |
| DC30 | 29445. | .5207+01 | .6850+04 | .7084-02 | .6077+03 | .3567+05 | .1095+00 |
| DC31 | 29445. | .5371+01 | .8397+04 | .1064-01 | .7684+03 | .4510+05 | .1302+00 |
| DC32 | 29445. | .5245+01 | .8460+04 | .1080-01 | .7561+03 | .4438+05 | .1343+00 |
| DC33 | 38386. | .9816+01 | .3177+04 | .1523-02 | .5312+03 | .3118+05 | .2695-01 |
| DC34 | 38386. | .9931+01 | .4045+04 | .2469-02 | .6844+03 | .4017+05 | .3391-01 |
| DC35 | 38386. | .9723+01 | .3847+04 | .2234-02 | .6374+03 | .3741+05 | .3295-01 |
| DC36 | 38386. | .9495+01 | .3788+04 | .2166-02 | .6128+03 | .3597+05 | .3322-01 |
| DC37 | 38386. | .9933+01 | .4045+04 | .2469-02 | .6845+03 | .4018+05 | .3390-01 |
| DC38 | 47775. | .1947+02 | .2036+04 | .6258-03 | .6754+03 | .3964+05 | .8708-02 |
| DC39 | 47775. | .2044+02 | .1464+04 | .3236-03 | .5100+03 | .2993+05 | .5963-02 |
| DC40 | 47626. | .2087+02 | .1778+04 | .4772-03 | .6321+03 | .3710+05 | .7095-02 |
| DC41 | 47626. | .1933+02 | .1815+04 | .4974-03 | .5979+03 | .3509+05 | .7818-02 |
| DC42 | 47626. | .1990+02 | .1309+04 | .2588-03 | .4440+03 | .2606+05 | .5478-02 |
| DC43 | 58803. | .4856+02 | .6695+03 | .6767-04 | .5540+03 | .3252+05 | .1148-02 |
| DC44 | 58803. | .4915+02 | .5245+03 | .4152-04 | .4392+03 | .2578+05 | .8884-03 |
| DC45 | 58654. | .4812+02 | .5803+03 | .5083-04 | .4757+03 | .2792+05 | .1004-02 |
| DC46 | 58803. | .4913+02 | .6323+03 | .6036-04 | .5293+03 | .3107+05 | .1072-02 |
| DC47 | 68936. | .1202+03 | .2172+03 | .7123-05 | .4450+03 | .2612+05 | .1504-03 |
| DC48 | 69234. | .1237+03 | .2541+03 | .9748-05 | .5354+03 | .3143+05 | .1711-03 |
| DC49 | 69234. | .1218+03 | .2499+03 | .9430-05 | .5186+03 | .3044+05 | .1709-03 |
| DC50 | 69085. | .1203+03 | .2457+03 | .9116-05 | .5038+03 | .2957+05 | .1700-03 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DC51 | 69085. | .1220+03 | .1492+03 | .3362-05 | .3102+03 | .1821+05 | .1018-03 |
| DC52 | 79070. | .3333+03 | .6772+02 | .6923-06 | .3846+03 | .2257+05 | .1692-04 |
| DC53 | 78921. | .4360+03 | .6982+02 | .7357-06 | .5186+03 | .3044+05 | .1333-04 |
| DC54 | 78921. | .4494+03 | .5376+02 | .4362-06 | .4116+03 | .2416+05 | .9966-05 |

DC200-20CS,210F,CAP4,3 24-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| DC-01 | 5398. | .3346+00 | .2399+05 | .8409-01 | .1368+03 | .8027+04 | .5778+01 |
| DC-02 | 5398. | .3152+00 | .3952+05 | .2282+00 | .2122+03 | .1246+05 | .1010+02 |
| DC-03 | 5359. | .3271+00 | .3003+05 | .1317+00 | .1673+03 | .9822+04 | .7398+01 |
| DC-04 | 5359. | .3269+00 | .4409+05 | .2840+00 | .2456+03 | .1441+05 | .1087+02 |
| DC-05 | 5320. | .3368+00 | .4330+05 | .2739+00 | .2485+03 | .1458+05 | .1036+02 |
| DC-06 | 11464. | .5769+00 | .1549+05 | .3506-01 | .1523+03 | .8938+04 | .2164+01 |
| DC-07 | 11542. | .5615+00 | .1539+05 | .3461-01 | .1473+03 | .8643+04 | .2209+01 |
| DC-08 | 11542. | .5561+00 | .2185+05 | .6973-01 | .2070+03 | .1215+05 | .3166+01 |
| DC-09 | 11503. | .5375+00 | .1880+05 | .5164-01 | .1722+03 | .1011+05 | .2819+01 |
| DC-10 | 11464. | .5401+00 | .2685+05 | .1053+00 | .2471+03 | .1450+05 | .4006+01 |
| DC-11 | 19460. | .9025+00 | .1493+05 | .3256-01 | .2296+03 | .1347+05 | .1333+01 |
| DC-12 | 19460. | .8864+00 | .1847+05 | .4981-01 | .2789+03 | .1637+05 | .1679+01 |
| DC-13 | 19311. | .8800+00 | .1267+05 | .2345-01 | .1900+03 | .1115+05 | .1160+01 |
| DC-14 | 19162. | .9639+00 | .1834+05 | .4911-01 | .3011+03 | .1767+05 | .1533+01 |
| DC-15 | 19162. | .9428+00 | .9528+04 | .1326-01 | .1530+03 | .8982+04 | .8143+00 |
| DC-17 | 49414. | .4624+01 | .2076+04 | .6293-03 | .1635+03 | .9597+04 | .3617-01 |
| DC-18 | 49414. | .4248+01 | .2358+04 | .8124-03 | .1707+03 | .1002+05 | .4473-01 |
| DC-19 | 49414. | .4669+01 | .2209+04 | .7131-03 | .1758+03 | .1032+05 | .3813-01 |
| DC-20 | 49861. | .4876+01 | .1904+04 | .5298-03 | .1582+03 | .9285+04 | .3147-01 |
| DC-21 | 49861. | .4645+01 | .2187+04 | .6988-03 | .1731+03 | .1016+05 | .3794-01 |
| DC-22 | 49861. | .4388+01 | .1957+04 | .5592-03 | .1463+03 | .8585+04 | .3593-01 |
| DC-23 | 66850. | .1150+02 | .9423+03 | .1297-03 | .1846+03 | .1084+05 | .6602-02 |
| DC-24 | 66850. | .1132+02 | .1547+04 | .3498-03 | .2984+03 | .1752+05 | .1101-01 |
| DC-25 | 66850. | .1117+02 | .1555+04 | .3531-03 | .2960+03 | .1737+05 | .1121-01 |
| DC-26 | 66850. | .1079+02 | .2068+04 | .6248-03 | .3803+03 | .2232+05 | .1544-01 |
| DC-27 | 66850. | .1126+02 | .1235+04 | .2228-03 | .2370+03 | .1391+05 | .8834-02 |
| DC-28 | 66850. | .1140+02 | .1845+04 | .4972-03 | .3583+03 | .2103+05 | .1304-01 |
| DC-29 | 79815. | .2239+02 | .6943+03 | .7043-04 | .2649+03 | .1555+05 | .2499-02 |
| DC-30 | 79815. | .2121+02 | .6051+03 | .5348-04 | .2187+03 | .1284+05 | .2298-02 |
| DC-31 | 79815. | .2043+02 | .7538+03 | .8302-04 | .2623+03 | .1540+05 | .2974-02 |
| DC-32 | 79666. | .2124+02 | .6646+03 | .6452-04 | .2405+03 | .1412+05 | .2521-02 |
| DC-33 | 79666. | .2245+02 | .1017+04 | .1510-03 | .3888+03 | .2282+05 | .3650-02 |
| DC-34 | 79666. | .2037+02 | .1106+04 | .1787-03 | .3838+03 | .2253+05 | .4375-02 |
| DC-35 | 79666. | .2151+02 | .9671+03 | .1366-03 | .3545+03 | .2081+05 | .3622-02 |

DC200-20CS;300F;CAP4,3 25-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| DC001 | 5350. | .2037+00 | .3417+05 | .1649+00 | .1186+03 | .6960+04 | .1307+02 |
| DC002 | 5350. | .2061+00 | .4905+05 | .3397+00 | .1722+03 | .1011+05 | .1854+02 |
| DC003 | 5350. | .1828+00 | .7156+05 | .7232+00 | .2228+03 | .1308+05 | .3050+02 |
| DC004 | 5350. | .1953+00 | .7880+05 | .8768+00 | .2622+03 | .1539+05 | .3143+02 |
| DC005 | 5389. | .1909+00 | .6674+05 | .6260+00 | .2171+03 | .1274+05 | .2723+02 |
| DC006 | 5389. | .1990+00 | .5575+05 | .4389+00 | .1891+03 | .1110+05 | .2182+02 |
| DC008 | 12194. | .3684+00 | .2573+05 | .9349-01 | .1615+03 | .9480+04 | .5440+01 |
| DC007 | 12234. | .3196+00 | .3152+05 | .1403+00 | .1716+03 | .1007+05 | .7683+01 |
| DC009 | 12194. | .3541+00 | .4684+05 | .3098+00 | .2826+03 | .1658+05 | .1030+02 |
| DC010 | 12194. | .3347+00 | .4825+05 | .3287+00 | .2751+03 | .1615+05 | .1123+02 |
| DC011 | 12194. | .3465+00 | .4362+05 | .2687+00 | .2575+03 | .1511+05 | .9807+01 |
| DC012 | 20354. | .5771+00 | .2310+05 | .7537-01 | .2271+03 | .1333+05 | .3118+01 |
| DC013 | 20354. | .5443+00 | .3033+05 | .1299+00 | .2813+03 | .1651+05 | .4341+01 |
| DC014 | 20354. | .6250+00 | .1760+05 | .4375-01 | .1874+03 | .1100+05 | .2194+01 |
| DC015 | 20354. | .5403+00 | .1289+05 | .2345-01 | .1186+03 | .6963+04 | .1858+01 |
| DC016 | 20354. | .5536+00 | .1650+05 | .3845-01 | .1557+03 | .9136+04 | .2322+01 |
| DC017 | 20354. | .5360+00 | .1434+05 | .2904-01 | .1310+03 | .7686+04 | .2084+01 |
| DC018 | 50159. | .2252+01 | .4893+04 | .3381-02 | .1877+03 | .1102+05 | .1693+00 |
| DC019 | 50159. | .2338+01 | .6377+04 | .5742-02 | .2540+03 | .1491+05 | .2124+00 |
| DC020 | 50308. | .2275+01 | .5998+04 | .5080-02 | .2324+03 | .1364+05 | .2054+00 |
| DC021 | 50308. | .2314+01 | .6503+04 | .5972-02 | .2564+03 | .1505+05 | .2189+00 |
| DC022 | 50308. | .2329+01 | .5714+04 | .4610-02 | .2267+03 | .1331+05 | .1911+00 |
| DC023 | 68638. | .4903+01 | .3177+04 | .1425-02 | .2653+03 | .1557+05 | .5047-01 |
| DC024 | 68638. | .4656+01 | .4301+04 | .2612-02 | .3412+03 | .2003+05 | .7196-01 |
| DC025 | 68638. | .4480+01 | .2644+04 | .9871-03 | .2018+03 | .1184+05 | .4597-01 |
| DC026 | 68638. | .4710+01 | .4222+04 | .2517-02 | .3388+03 | .1989+05 | .6983-01 |
| DC027 | 68638. | .4602+01 | .3887+04 | .2133-02 | .3048+03 | .1789+05 | .6579-01 |
| DC028 | 81603. | .7166+01 | .1860+04 | .4884-03 | .2270+03 | .1333+05 | .2022-01 |
| DC029 | 81603. | .7038+01 | .2500+04 | .8823-03 | .2997+03 | .1759+05 | .2766-01 |
| DC030 | 81603. | .7067+01 | .2507+04 | .8875-03 | .3019+03 | .1772+05 | .2763-01 |
| DC031 | 81603. | .6519+01 | .3343+04 | .1578-02 | .3713+03 | .2179+05 | .3994-01 |
| DC032 | 81603. | .7176+01 | .3690+04 | .1923-02 | .4511+03 | .2648+05 | .4005-01 |

****************************************************AVERAGED DATA POINTS********

DC200-20CS,CAP4,100F,3-23-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .39100+02 |
| .53657+04 | .72110+02 |
| .11194+05 | .12259+03 |
| .19878+05 | .25050+03 |
| .29445+05 | .52787+03 |
| .38386+05 | .97799+03 |
| .47685+05 | .20003+04 |
| .58765+05 | .48742+04 |
| .69115+05 | .12161+05 |
| .78921+05 | .44270+05 |

ALPHA STAR= .96336-04
ALPHA OT= .13550-03

DC200-20CS,210F,CAP4,3 24-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .15200+02 |
| .53667+04 | .32812+02 |
| .11503+05 | .55443+02 |
| .19311+05 | .91511+02 |
| .49638+05 | .45749+03 |
| .66850+05 | .11242+04 |
| .79730+05 | .21371+04 |

ALPHA STAR= .95620-04
ALPHA OT= .20481-03

DC200-20CS,300F,CAP4,3 25-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .84600+01 |
| .53631+04 | .19630+02 |
| .12202+05 | .34464+02 |
| .20354+05 | .56270+02 |
| .50249+05 | .23016+03 |
| .68638+05 | .46701+03 |
| .61603+05 | .69932+03 |

ALPHA STAR= .95546-04
ALPHA OT= .24187-03

**********************************************************RAW DATA POINTS****************

DC200-20CS,CAP1,100F,4-19-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| DC01 | 11057. | .8195+00 | .2413+06 | .5707+01 | .1633+03 | .1977+06 | .1592+02 |
| DC02 | 11057. | .1086+01 | .2125+06 | .4426+01 | .1905+03 | .2307+06 | .1058+02 |
| DC03 | 11057. | .1121+01 | .2495+06 | .6101+01 | .2309+03 | .2796+06 | .1203+02 |
| DC04 | 11057. | .1144+01 | .2868+06 | .8063+01 | .2709+03 | .3281+06 | .1356+02 |
| DC05 | 11057. | .1006+01 | .2259+06 | .5002+01 | .1877+03 | .2273+06 | .1214+02 |
| DC06 | 11019. | .1647+01 | .3280+06 | .1055+02 | .4461+03 | .5403+06 | .1077+02 |
| DC07 | 11019. | .9813+00 | .6207+06 | .3777+02 | .5030+03 | .6091+06 | .3420+02 |
| DC08 | 10943. | .8903+00 | .4911+06 | .2365+02 | .3610+03 | .4372+06 | .2983+02 |
| DC09 | 10943. | .9571+00 | .5001+06 | .2452+02 | .3953+03 | .4787+06 | .2826+02 |
| DC10 | 10904. | .9226+00 | .6128+06 | .3681+02 | .4668+03 | .5653+06 | .3592+02 |
| DC11 | 10904. | .9030+00 | .6804+06 | .4538+02 | .5073+03 | .6144+06 | .4074+02 |
| DC12 | 10904. | .8721+00 | .8706+06 | .7568+02 | .6327+03 | .7663+06 | .5448+02 |
| DC13 | 10904. | .9559+00 | .7705+06 | .5820+02 | .6082+03 | .7365+06 | .4359+02 |
| DC14 | 10904. | .8985+00 | .8471+06 | .7034+02 | .6284+03 | .7611+06 | .5098+02 |
| DC15 | 19382. | .2124+01 | .2229+06 | .4872+01 | .3910+03 | .4735+06 | .5676+01 |
| DC16 | 19456. | .1997+01 | .2770+06 | .7521+01 | .4567+03 | .5531+06 | .7501+01 |
| DC17 | 19456. | .2113+01 | .3178+06 | .9901+01 | .5545+03 | .6716+06 | .8133+01 |
| DC18 | 19530. | .2002+01 | .4111+06 | .1657+02 | .6795+03 | .8229+06 | .1111+02 |
| DC19 | 19530. | .1976+01 | .4869+06 | .2324+02 | .7946+03 | .9623+06 | .1332+02 |
| DC20 | 19677. | .1794+01 | .6269+06 | .3852+02 | .9284+03 | .1124+07 | .1890+02 |
| DC21 | 19677. | .1869+01 | .5948+06 | .3468+02 | .9177+03 | .1111+07 | .1721+02 |
| DC22 | 19677. | .1910+01 | .5394+06 | .2852+02 | .8508+03 | .1030+07 | .1527+02 |
| DC23 | 19677. | .2021+01 | .4753+06 | .2214+02 | .7932+03 | .9607+06 | .1271+02 |
| DC24 | 19677. | .1911+01 | .4636+06 | .2107+02 | .7317+03 | .8861+06 | .1311+02 |
| DC25 | 19677. | .1910+01 | .4519+06 | .2002+02 | .7128+03 | .8632+06 | .1279+02 |
| DC26 | 30580. | .4843+01 | .5248+05 | .2700+00 | .2099+03 | .2542+06 | .5860+00 |
| DC27 | 30580. | .4908+01 | .6560+05 | .4219+00 | .2659+03 | .3220+06 | .7228+00 |
| DC28 | 30874. | .5161+01 | .6868+05 | .4624+00 | .2927+03 | .3544+06 | .7196+00 |
| DC29 | 30874. | .5403+01 | .5850+05 | .3355+00 | .2610+03 | .3161+06 | .5856+00 |
| DC30 | 30727. | .4860+01 | .1262+06 | .1560+01 | .5063+03 | .6132+06 | .1404+01 |
| DC31 | 30580. | .4947+01 | .1108+06 | .1203+01 | .4526+03 | .5482+06 | .1211+01 |
| DC32 | 30580. | .4771+01 | .1574+06 | .2430+01 | .6203+03 | .7512+06 | .1785+01 |
| DC33 | 30580. | .4577+01 | .2376+06 | .5536+01 | .8980+03 | .1088+07 | .2808+01 |
| DC34 | 30580. | .4620+01 | .2260+06 | .5006+01 | .8620+03 | .1044+07 | .2645+01 |
| DC35 | 30580. | .4369+01 | .2682+06 | .7054+01 | .9676+03 | .1172+07 | .3320+01 |
| DC01 | 47007. | .1782+02 | .2009+05 | .3959-01 | .2956+03 | .3580+06 | .6099-01 |
| DC03 | 46933. | .1568+02 | .6105+05 | .3653+00 | .7906+03 | .9574+06 | .2105+00 |
| DC04 | 46933. | .1561+02 | .6359+05 | .3964+00 | .8407+03 | .1018+07 | .2148+00 |
| DC05 | 46786. | .1725+02 | .2798+05 | .7675-01 | .3985+03 | .4826+06 | .8773-01 |
| DC06 | 46786. | .1674+02 | .8394+04 | .6907-02 | .1160+03 | .1405+06 | .2712-01 |
| DC07 | 46786. | .1743+02 | .8394+04 | .6907-02 | .1208+03 | .1463+06 | .2604-01 |
| DC08 | 46786. | .1572+02 | .4833+05 | .2290+00 | .6271+03 | .7595+06 | .1663+00 |
| DC09 | 46786. | .1652+02 | .5443+05 | .2905+00 | .7424+03 | .8991+06 | .1782+00 |
| DC10 | 46786. | .1567+02 | .6664+05 | .4354+00 | .8624+03 | .1044+07 | .2299+00 |
| DC11 | 46786. | .1618+02 | .7377+04 | .5334-02 | .9858+02 | .1194+06 | .2465-01 |
| DC12 | 46786. | .1672+02 | .2442+05 | .5846-01 | .3371+03 | .4083+06 | .7897-01 |
| DC13 | 46786. | .1592+02 | .2035+05 | .4059-01 | .2674+03 | .3239+06 | .6914-01 |
| DC14 | 46785. | .1617+02 | .3917+05 | .1504+00 | .5232+03 | .6336+06 | .1310+00 |
| DC15 | 46786. | .1550+02 | .6206+05 | .3776+00 | .7945+03 | .9621+06 | .2165+00 |
| DC16 | 46786. | .1450+02 | .7377+05 | .5334+00 | .8829+03 | .1069+07 | .2752+00 |
| DC17 | 46786. | .1622+02 | .7224+05 | .5116+00 | .9678+03 | .1172+07 | .2406+00 |
| DC18 | 46786. | .1447+02 | .8954+05 | .7859+00 | .1070+04 | .1296+07 | .3346+00 |
| DC19 | 46786. | .1631+02 | .3866+05 | .1465+00 | .5207+03 | .6306+06 | .1282+00 |
| DC20 | 46786. | .1623+02 | .4731+05 | .2194+00 | .6340+03 | .7678+06 | .1576+00 |

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1318-88-13,CAP4,100F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5287. | .6113+01 | .2268+04 | .8425-03 | .2362+03 | .1386+05 | .3353-01 |
| 100-2 | 5287. | .5977+01 | .4229+04 | .2931-02 | .4307+03 | .2528+05 | .6396-01 |
| 100-3 | 5287. | .6083+01 | .3592+04 | .2115-02 | .3723+03 | .2185+05 | .5338-01 |
| 100-4 | 5287. | .6175+01 | .5045+04 | .4170-02 | .5307+03 | .3115+05 | .7384-01 |
| 100-5 | 5287. | .6235+01 | .2930+04 | .1407-02 | .3112+03 | .1827+05 | .4247-01 |
| 100-6 | 5287. | .6267+01 | .5401+04 | .4781-02 | .5767+03 | .3385+05 | .7790-01 |
| 100-7 | 11087. | .1974+02 | .2140+04 | .7505-03 | .7197+03 | .4225+05 | .9799-02 |
| 100-8 | 11010. | .1962+02 | .6980+03 | .7983-04 | .2333+03 | .1370+05 | .3215-02 |
| 100-9 | 11010. | .1883+02 | .1269+04 | .2639-03 | .4071+03 | .2389+05 | .6092-02 |
| 100-10 | 11010. | .1878+02 | .1602+04 | .4206-03 | .5126+03 | .3009+05 | .7711-02 |
| 100-11 | 11010. | .1925+02 | .8249+03 | .1115-03 | .2706+03 | .1588+05 | .3872-02 |
| 100-12 | 11010. | .1974+02 | .1491+04 | .3643-03 | .5014+03 | .2943+05 | .6828-02 |
| 100-13 | 11010. | .1926+02 | .2353+04 | .9072-03 | .7720+03 | .4532+05 | .1104-01 |
| 100-14 | 11010. | .1894+02 | .3120+04 | .1595-02 | .1007+04 | .5908+05 | .1489-01 |
| 100-15 | 21445. | .2608+03 | .1089+03 | .1941-05 | .4836+03 | .2838+05 | .3773-04 |
| 100-16 | 21445. | .2636+03 | .1647+03 | .4447-05 | .7400+03 | .4344+05 | .5648-04 |
| 100-17 | 21445. | .2836+03 | .2133+03 | .7454-05 | .1031+04 | .6049+05 | .6797-04 |
| 100-18 | 21371. | .2689+03 | .1559+03 | .3983-05 | .7144+03 | .4193+05 | .5240-04 |
| 100-19 | 21371. | .2845+03 | .2177+03 | .7766-05 | .1055+04 | .6193+05 | .6917-04 |
| 100-20 | 21298. | .2667+03 | .2177+03 | .7766-05 | .9891+03 | .5806+05 | .7378-04 |
| 100-21 | 21298. | .2910+03 | .5246+02 | .4509-06 | .2601+03 | .1527+05 | .1629-04 |
| 100-22 | 21224. | .2430+03 | .1077+03 | .1900-05 | .4457+03 | .2616+05 | .4005-04 |
| 100-23 | 21150. | .2593+03 | .1426+03 | .3334-05 | .6301+03 | .3698+05 | .4973-04 |

1318-88-13,CAP4,210F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-1 | 5359. | .6256+00 | .1572+05 | .3869-01 | .1676+03 | .9835+04 | .2170+01 |
| 210-2 | 5359. | .5991+00 | .1478+05 | .3420-01 | .1509+03 | .8855+04 | .2131+01 |
| 210-3 | 5359. | .5988+00 | .2341+05 | .8579-01 | .2388+03 | .1402+05 | .3376+01 |
| 210-4 | 5359. | .5758+00 | .1367+05 | .2925-01 | .1341+03 | .7871+04 | .2050+01 |
| 210-5 | 5359. | .5835+00 | .2725+05 | .1163+00 | .2709+03 | .1590+05 | .4033+01 |
| 210-6 | 5359. | .6459+00 | .1700+05 | .4525-01 | .1871+03 | .1098+05 | .2273+01 |
| 210-7 | 11194. | .1108+01 | .1111+05 | .1931-01 | .2096+03 | .1230+05 | .8660+00 |
| 210-8 | 11194. | .1146+01 | .1610+05 | .4056-01 | .3144+03 | .1845+05 | .1213+01 |
| 210-9 | 11194. | .1206+01 | .7775+04 | .9463-02 | .1597+03 | .9374+04 | .5569+00 |
| 210-10 | 11194. | .1083+01 | .1786+05 | .4992-01 | .3294+03 | .1933+05 | .1424+01 |
| 210-11 | 11194. | .1106+01 | .6835+04 | .7313-02 | .1288+03 | .7559+04 | .5337+00 |
| 210-12 | 11194. | .1125+01 | .1085+05 | .1843-01 | .2079+03 | .1220+05 | .8332+00 |
| 210-13 | 11194. | .1256+01 | .1487+05 | .3460-01 | .3180+03 | .1867+05 | .1022+01 |
| 210-14 | 11194. | .1117+01 | .6835+04 | .7313-02 | .1300+03 | .7633+04 | .5285+00 |
| 210-15 | 20652. | .3003+01 | .3380+04 | .1789-02 | .1729+03 | .1015+05 | .9720-01 |
| 210-16 | 20652. | .3236+01 | .3718+04 | .2164-02 | .2050+03 | .1203+05 | .9923-01 |
| 210-17 | 20652. | .2882+01 | .8451+04 | .1118-01 | .4150+03 | .2436+05 | .2532+00 |
| 210-18 | 20652. | .2826+01 | .1445+05 | .3269-01 | .6957+03 | .4083+05 | .4416+00 |
| 210-19 | 20652. | .3050+01 | .4859+04 | .3696-02 | .2525+03 | .1482+05 | .1376+00 |
| 210-20 | 20652. | .3031+01 | .7014+04 | .7702-02 | .3621+03 | .2126+05 | .1999+00 |

1318-88-13,CAP4,300F

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5337. | .2538+00 | .3506+05 | .1868+00 | .1516+03 | .8898+04 | .1158+02 |
| 300-2 | 5337. | .2768+00 | .3207+05 | .1563+00 | .1513+03 | .8879+04 | .9709+01 |
| 300-3 | 5337. | .2331+00 | .3068+05 | .1430+00 | .1218+03 | .7151+04 | .1103+02 |
| 300-4 | 5337. | .2679+00 | .4363+05 | .2918+00 | .2000+03 | .1174+05 | .1371+02 |
| 300-5 | 5337. | .2820+00 | .2769+05 | .1165+00 | .1330+03 | .7808+04 | .8230+01 |
| 300-6 | 5337. | .2302+00 | .3426+05 | .1784+00 | .1344+03 | .7886+04 | .1248+02 |
| 300-7 | 11112. | .4022+00 | .3247+05 | .1602+00 | .2225+03 | .1306+05 | .6765+01 |
| 300-8 | 11190. | .4100+00 | .1594+05 | .3859-01 | .1113+03 | .6534+04 | .3257+01 |
| 300-9 | 11112. | .4111+00 | .2610+05 | .1035+00 | .1828+03 | .1073+05 | .5319+01 |
| 300-10 | 11112. | .4024+00 | .1892+05 | .5441-01 | .1298+03 | .7616+04 | .3941+01 |
| 300-11 | 20324. | .8233+00 | .1313+05 | .2620-01 | .1842+03 | .1081+05 | .1337+01 |
| 300-12 | 20324. | .8142+00 | .1147+05 | .2000-01 | .1592+03 | .9343+04 | .1181+01 |
| 300-13 | 20324. | .8310+00 | .8159+04 | .1011-01 | .1155+03 | .6781+04 | .8228+00 |
| 300-14 | 20324. | .8291+00 | .9052+04 | .1245-01 | .1279+03 | .7505+04 | .9149+00 |
| 300-15 | 20324. | .7671+00 | .7395+04 | .8307-02 | .9664+02 | .5672+04 | .8078+00 |

*****************************************************AVERAGED DATA POINTS**********

1318-88-13,CAP4,100F

| P (PSI) | V (CP) |
|---|---|
| .00000 | .25900+03 |
| .52866+04 | .61416+03 |
| .11020+05 | .19269+04 |
| .21339+05 | .26904+05 |

ALPHA STAR= .17897-03
ALPHA OT= .17146-03

1318-88-13,CAP4,210F

| P (PSI) | V (CP) |
|---|---|
| .00000 | .34500+02 |
| .53590+04 | .60479+02 |
| .11194+05 | .11431+03 |
| .20652+05 | .30047+03 |

ALPHA STAR= .11033-03
ALPHA OT= .10859-03

1318-88-13,CAP4,300F

| P (PSI) | V (CP) |
|---|---|
| .00000 | .13870+02 |
| .53374+04 | .25729+02 |
| .11132+05 | .40645+02 |
| .20324+05 | .81295+02 |

ALPHA STAR= .98714-04
ALPHA OT= .14967-03

1318-88-13,CAP1,100F,8-20-71

| RUN | PS | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11125. | .2420+02 | .5939+04 | .3754-02 | .1187+03 | .1437+06 | .1441-01 |
| 100-2 | 11125. | .2181+02 | .1006+05 | .1077-01 | .1812+03 | .2194+06 | .2708-01 |
| 100-3 | 11125. | .2410+02 | .1892+05 | .3770-01 | .3749+03 | .4540+06 | .4581-01 |
| 100-4 | 11068. | .2276+02 | .1136+05 | .1373-01 | .2134+03 | .2585+06 | .2930-01 |
| 100-5 | 11068. | .217[illegible]+02 | .1096+05 | .4239-01 | .3581+03 | .4337+06 | .5392-01 |
| 100-6 | 11068. | .1915+02 | .4706+05 | .2357+00 | .7443+03 | .9013+06 | .1442+00 |
| 100-7 | 11202. | .1951+02 | .3722+05 | .1474+00 | .5997+03 | .7263+06 | .1120+00 |
| 100-8 | 10991. | .1771+02 | .5206+05 | .2884+00 | .7611+03 | .9217+06 | .1726+00 |
| 100-9 | 10875. | .1043+02 | .3911+05 | .1627+00 | .5953+03 | .7209+06 | .1245+00 |
| 100-10 | 10875. | .1714+02 | .6149+05 | .4023+00 | .8704+03 | .1054+07 | .2105+00 |
| 100-11 | 11164. | .2305+02 | .1157+05 | .1424-01 | .2202+03 | .2666+06 | .2946-01 |
| 100-12 | 11164. | .2274+02 | .1383+05 | .2036-01 | .2598+03 | .3146+06 | .3570-01 |
| 100-13 | 11125. | .1530+02 | .6978+04 | .5181-02 | .8867+02 | .1074+06 | .2661-01 |
| 100-14 | 11106. | .1962+02 | .2707+04 | .7796-03 | .4385+02 | .5311+05 | .9098-02 |
| 100-15 | 11106. | .2204+02 | .5647+04 | .3393-02 | .1056+03 | .1278+06 | .1464-01 |
| 100-16 | 11106. | .2249+02 | .8130+04 | .7033-02 | .1510+03 | .1828+06 | .2122-01 |
| 100-17 | 11125. | .2313+02 | .1712+04 | .3121-03 | .3271+02 | .3962+05 | .4345-02 |
| 100-18 | 11125. | .2278+02 | .2910+04 | .9009-03 | .5473+02 | .6628+05 | .7498-02 |
| 100-19 | 11106. | .2233+02 | .2152+04 | .4923-03 | .3967+02 | .4805+05 | .5658-02 |
| 100-20 | 11106. | .2337+02 | .3940+04 | .1652-02 | .7605+02 | .9210+05 | .9895-02 |
| 100-21 | 21740. | .4232+03 | .2475+04 | .6517-03 | .8660+03 | .1049+07 | .3428-03 |
| 100-22 | 21740. | .3504+03 | .3190+04 | .1083-02 | .9231+03 | .1118+07 | .5344-03 |
| 100-23 | 21740. | .3570+03 | .1342+04 | .1916-03 | .3955+03 | .4789+06 | .2206-03 |
| 100-24 | 21740. | .3723+03 | .1978+04 | .3755-03 | .5774+03 | .6993+06 | .2962-03 |
| 100-25 | 21740. | .3719+03 | .2385+04 | .6054-03 | .7325+03 | .8871+06 | .3765-03 |
| 100-26 | 21740. | .3333+03 | .3975+04 | .1682-02 | .1094+04 | .1325+07 | .7002-03 |
| 100-27 | 21740. | .3616+03 | .2952+04 | .9272-03 | .8814+03 | .1067+07 | .4791-03 |
| 100-28 | 21740. | .3297+03 | .4423+04 | .2081-02 | .1204+04 | .1458+07 | .7874-03 |
| 100-29 | 21740. | .3302+03 | .2024+03 | .4357-05 | .5517+02 | .6681+05 | .3598-04 |
| 100-30 | 21740. | .3905+03 | .3597+03 | .1377-04 | .1160+03 | .1405+06 | .5407-04 |
| 100-31 | 21740. | .4027+03 | .6464+03 | .4447-04 | .2150+03 | .2603+06 | .9422-04 |
| 100-32 | 21740. | .3097+03 | .8432+02 | .7565-06 | .2783+02 | .3370+05 | .1238-04 |
| 100-33 | 21740. | .3525+03 | .2024+03 | .4357-05 | .5891+02 | .7134+05 | .3369-04 |
| 100-34 | 21740. | .3245+03 | .8704+02 | .8062-06 | .2332+02 | .2824+05 | .1575-04 |
| 100-35 | 21740. | .2974+03 | .5737+02 | .3502-06 | .1409+02 | .1706+05 | .1132-04 |
| 100-36 | 21740. | .3347+03 | .1451+03 | .2239-05 | .4009+02 | .4855+05 | .2544-04 |

1318-88-14,CAP4,100F,8-14-7

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 5359. | .1327+01 | .4699+04 | .3355-02 | .1063+03 | .6237+04 | .2967+00 |
| 100-2 | 5359. | .1466+01 | .9569+04 | .1391-01 | .2390+03 | .1403+05 | .5469+00 |
| 100-3 | 5359. | .1448+01 | .1094+05 | .1817-01 | .2698+03 | .1583+05 | .6330+00 |
| 100-4 | 5359. | .1613+01 | .4272+04 | .2772-02 | .1174+03 | .6890+04 | .2220+00 |
| 100-5 | 5359. | .1482+01 | .1162+05 | .2051-01 | .2934+03 | .1722+05 | .6569+00 |
| 100-6 | 5359. | .1476+01 | .2179+05 | .7211-01 | .5477+03 | .3215+05 | .1237+01 |
| 100-7 | 11213. | .3011+01 | .5041+04 | .3860-02 | .2586+03 | .1518+05 | .1403+00 |
| 100-8 | 11175. | .3179+01 | .2050+04 | .6388-03 | .1111+03 | .6519+04 | .5405-01 |
| 100-9 | 11175. | .3169+01 | .3930+04 | .2347-02 | .2122+03 | .1245+05 | .1039+00 |
| 100-10 | 11175. | .3079+01 | .5425+04 | .4472-02 | .2846+03 | .1670+05 | .1477+00 |
| 100-11 | 11175. | .3042+01 | .7946+04 | .9591-02 | .4118+03 | .2417+05 | .2189+00 |
| 100-12 | 11117. | .3194+01 | .3417+04 | .1774-02 | .1860+03 | .1092+05 | .8966-01 |
| 100-13 | 11117. | .3102+01 | .5810+04 | .5128-02 | .3071+03 | .1802+05 | .1569+00 |
| 100-14 | 11117. | .3126+01 | .9142+04 | .1270-01 | .4868+03 | .2857+05 | .2451+00 |
| 100-15 | 11117. | .3048+01 | .1341+05 | .2733-01 | .6966+03 | .4089+05 | .3688+00 |
| 100-16 | 11117. | .2986+01 | .1880+05 | .5367-01 | .9564+03 | .5613+05 | .5274+00 |
| 100-17 | 11059. | .3086+01 | .1555+04 | .3673-03 | .8175+02 | .4798+04 | .4223-01 |
| 100-18 | 11059. | .3045+01 | .2640+04 | .1059-02 | .1369+03 | .8038+04 | .7266-01 |
| 100-19 | 11039. | .2815+01 | .7181+03 | .7835-04 | .3444+02 | .2022+04 | .2138-01 |
| 100-20 | 11039. | .3077+01 | .1330+04 | .2687-03 | .6971+02 | .4092+04 | .3622-01 |
| 100-21 | 11039. | .2920+01 | .1968+04 | .5885-03 | .9792+02 | .5748+04 | .5648-01 |
| 100-22 | 10981. | .2961+01 | .5479+04 | .4561-02 | .2764+03 | .1622+05 | .1551+00 |
| 100-23 | 10981. | .2998+01 | .7181+04 | .7835-02 | .3668+03 | .2153+05 | .2007+00 |
| 100-24 | 10981. | .2834+01 | .6277+03 | .5986-04 | .3030+02 | .1779+04 | .1856-01 |
| 100-25 | 19609. | .1026+02 | .1073+04 | .1750-03 | .1876+03 | .1101+05 | .8770-02 |
| 100-26 | 19609. | .1050+02 | .1310+04 | .2608-03 | .2343+03 | .1375+05 | .1046-01 |
| 100-27 | 19609. | .9635+01 | .2315+04 | .8142-03 | .3800+03 | .2231+05 | .2014-01 |
| 100-28 | 19460. | .9248+01 | .1552+04 | .3660-03 | .2445+03 | .1435+05 | .1407-01 |
| 100-29 | 19460. | .9410+01 | .2157+04 | .7070-03 | .3458+03 | .2030+05 | .1921-01 |
| 100-30 | 19460. | .8835+01 | .3446+04 | .1804-02 | .5187+03 | .3045+05 | .3269-01 |
| 100-31 | 19460. | .9157+01 | .3341+04 | .1696-02 | .5212+03 | .3059+05 | .3058-01 |
| 100-32 | 19460. | .9690+01 | .5603+04 | .4770-02 | .9251+03 | .5430+05 | .4846-01 |
| 100-33 | 19460. | .9370+01 | .2499+04 | .9489-03 | .3989+03 | .2342+05 | .2235-01 |
| 100-34 | 19460. | .9149+01 | .4025+04 | .2461-02 | .6274+03 | .3683+05 | .3687-01 |
| 100-35 | 19460. | .9451+01 | .6182+04 | .5806-02 | .9954+03 | .5843+05 | .5482-01 |
| 100-36 | 19460. | .8345+01 | .4735+03 | .3407-04 | .6732+02 | .3951+04 | .4755-02 |
| 100-37 | 19460. | .8873+01 | .9123+03 | .1265-03 | .1379+03 | .8095+04 | .8616-02 |
| 100-38 | 19460. | .8752+01 | .1247+04 | .2362-03 | .1859+03 | .1091+05 | .1194-01 |
| 100-41 | 19460. | .8943+01 | .1994+03 | .6039-05 | .3038+02 | .1783+04 | .1868-02 |
| 100-42 | 19460. | .1037+02 | .6447+03 | .6315-04 | .1139+03 | .6684+04 | .5212-02 |
| 100-43 | 29296. | .4334+02 | .4265+03 | .2764-04 | .3149+03 | .1849+05 | .8247-03 |
| 100-44 | 29296. | .4414+02 | .6547+03 | .6511-04 | .4923+03 | .2889+05 | .1243-02 |
| 100-45 | 29296. | .4311+02 | .3918+03 | .2332-04 | .2878+03 | .1689+05 | .7616-03 |
| 100-46 | 29296. | .4202+02 | .7935+03 | .9566-04 | .5681+03 | .3334+05 | .1582-02 |
| 100-47 | 29296. | .3811+02 | .2827+03 | .1214-04 | .1835+03 | .1077+05 | .6217-03 |
| 100-48 | 29296. | .4010+02 | .4067+03 | .2513-04 | .2779+03 | .1631+05 | .8498-03 |
| 100-51 | 39653. | .2847+03 | .2083+03 | .6592-05 | .1010+04 | .5930+05 | .6132-04 |
| 100-52 | 39653. | .2941+03 | .2500+03 | .9492-05 | .1252+04 | .7350+05 | .7124-04 |
| 100-53 | 39579. | .2636+03 | .7261+02 | .8009-06 | .3260+03 | .1914+05 | .2309-04 |
| 100-54 | 39579. | .2832+03 | .6144+02 | .5734-06 | .2964+03 | .1740+05 | .1818-04 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100-55 | 39579. | .2766+03 | .9984+02 | .1514-05 | .4705+03 | .2762+05 | .3024-04 |
| 100-56 | 39579. | .2265+03 | .1459+03 | .3235-05 | .5631+03 | .3305+05 | .5398-04 |
| 100-57 | 39579. | .2916+03 | .6563+02 | .6543-06 | .3260+03 | .1913+05 | .1886-04 |
| 100-58 | 39579. | .2607+03 | .9565+02 | .1390-05 | .4248+03 | .2493+05 | .3075-04 |
| 100-59 | 39579. | .2841+03 | .1536+03 | .3584-05 | .7434+03 | .4363+05 | .4531-04 |

1318-88-14,CAP4,210F,8-17-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 210-1 | 5336. | .2801+00 | .2594+05 | .9831-01 | .1238+03 | .7266+04 | .7463+01 |
| 210-2 | 5336. | .2876+00 | .5596+05 | .4575+00 | .2742+03 | .1610+05 | .1568+02 |
| 210-3 | 5336. | .2860+00 | .4225+05 | .2607+00 | .2059+03 | .1208+05 | .1190+02 |
| 210-4 | 5336. | .2900+00 | .3113+05 | .1416+00 | .1538+03 | .9028+04 | .8649+01 |
| 210-5 | 5336. | .2881+00 | .4670+05 | .3185+00 | .2292+03 | .1345+05 | .1306+02 |
| 210-6 | 5336. | .2822+00 | .5225+05 | .3989+00 | .2512+03 | .1475+05 | .1492+02 |
| 210-7 | 11501. | .5097+00 | .1977+05 | .5707-01 | .1716+03 | .1007+05 | .3125+01 |
| 210-8 | 11393. | .4832+00 | .4355+05 | .2770+00 | .3585+03 | .2104+05 | .7262+01 |
| 210-9 | 11393. | .4893+00 | .3910+05 | .2233+00 | .3260+03 | .1913+05 | .6438+01 |
| 210-10 | 11393. | .4877+00 | .2187+05 | .6984-01 | .1817+03 | .1066+05 | .3613+01 |
| 210-11 | 11357. | .4893+00 | .3502+05 | .1792+00 | .2920+03 | .1714+05 | .5767+01 |
| 210-12 | 23175. | .1284+01 | .1208+05 | .2130-01 | .2642+03 | .1551+05 | .7577+00 |
| 210-13 | 23034. | .1317+01 | .1480+05 | .3200-01 | .3322+03 | .1950+05 | .9053+00 |
| 210-14 | 23034. | .1299+01 | .1170+05 | .2001-01 | .2591+03 | .1521+05 | .7258+00 |
| 210-17 | 22893. | .1242+01 | .9660+04 | .1363-01 | .2043+03 | .1199+05 | .6269+00 |
| 210-18 | 33039. | .2988+01 | .5714+04 | .4769-02 | .2909+03 | .1707+05 | .1541+00 |
| 210-19 | 33039. | .2885+01 | .9070+04 | .1202-01 | .4458+03 | .2616+05 | .2534+00 |
| 210-20 | 33039. | .2904+01 | .8311+04 | .1009-01 | .4112+03 | .2413+05 | .2306+00 |
| 210-21 | 33039. | .2861+01 | .4795+04 | .3358-02 | .2337+03 | .1372+05 | .1350+00 |
| 210-22 | 33039. | .2957+01 | .8231+04 | .9897-02 | .4147+03 | .2434+05 | .2243+00 |
| 210-23 | 41495. | .5877+01 | .2637+04 | .1016-02 | .2640+03 | .1550+05 | .3616-01 |
| 210-24 | 41495. | .5995+01 | .4553+04 | .3028-02 | .4650+03 | .2729+05 | .6119-01 |
| 210-25 | 41354. | .5934+01 | .5199+04 | .3949-02 | .5257+03 | .3085+05 | .7060-01 |
| 210-26 | 41354. | .5949+01 | .2719+04 | .1080-02 | .2756+03 | .1618+05 | .3683-01 |
| 210-27 | 41354. | .6021+01 | .4702+04 | .3229-02 | .4823+03 | .2831+05 | .6293-01 |
| 210-28 | 47526. | .9056+01 | .1940+04 | .5500-03 | .2994+03 | .1757+05 | .1726-01 |
| 210-29 | 47526. | .9806+01 | .1607+04 | .3773-03 | .2685+03 | .1576+05 | .1321-01 |
| 210-30 | 47498. | .1041+02 | .1891+04 | .5222-03 | .3352+03 | .1967+05 | .1464-01 |
| 210-31 | 47498. | .1004+02 | .2214+04 | .7161-03 | .3789+03 | .2224+05 | .1776-01 |

1318-88-14,CAP4,300F,8-17-71

| RUN | P3 | VISCP | NSRATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 300-1 | 5355. | .1475+00 | .5408+05 | .4116+00 | .1359+03 | .7978+04 | .2846+02 |
| 300-2 | 5355. | .1522+00 | .7626+05 | .8184+00 | .1978+03 | .1161+05 | .3889+02 |
| 300-3 | 5355. | .1444+00 | .3910+05 | .2152+00 | .9618+02 | .5646+04 | .2102+02 |
| 300-4 | 5355. | .1313+00 | .4397+05 | .2720+00 | .9832+02 | .5771+04 | .2600+02 |
| 300-5 | 5355. | .1522+00 | .5058+05 | .3600+00 | .1312+03 | .7700+04 | .2579+02 |
| 300-6 | 11260. | .2494+00 | .3755+05 | .1984+00 | .1596+03 | .9365+04 | .1168+02 |
| 300-7 | 11203. | .2284+00 | .4046+05 | .2304+00 | .1575+03 | .9243+04 | .1375+02 |
| 300-8 | 11203. | .2536+00 | .2432+05 | .8321-01 | .1051+03 | .6166+04 | .7444+01 |
| 300-9 | 11184. | .2311+00 | .5019+05 | .3545+00 | .1976+03 | .1160+05 | .1686+02 |
| 300-10 | 11108. | .2298+00 | .4241+05 | .2531+00 | .1660+03 | .9745+04 | .1433+02 |
| 300-11 | 11108. | .2312+00 | .3288+05 | .1521+00 | .1295+03 | .7601+04 | .1104+02 |
| 300-12 | 20126. | .4610+00 | .2115+05 | .6296-01 | .1661+03 | .9751+04 | .3561+01 |
| 300-13 | 20126. | .4503+00 | .1423+05 | .2848-01 | .1092+03 | .6407+04 | .2452+01 |
| 300-14 | 20126. | .4227+00 | .2644+05 | .9837-01 | .1904+03 | .1118+05 | .4856+01 |
| 300-15 | 20126. | .4570+00 | .1599+05 | .3598-01 | .1245+03 | .7307+04 | .2716+01 |
| 300-16 | 20126. | .4748+00 | .2757+05 | .1070+00 | .2230+03 | .1309+05 | .4508+01 |
| 300-17 | 30369. | .8178+00 | .5980+04 | .5033-02 | .8332+02 | .4890+04 | .5677+00 |
| 300-18 | 30369. | .8453+00 | .1775+05 | .4435-01 | .2557+03 | .1501+05 | .1630+01 |
| 300-19 | 30369. | .8728+00 | .7554+04 | .8030-02 | .1123+03 | .6593+04 | .6718+00 |
| 300-20 | 30369. | .7773+00 | .1221+05 | .2099-01 | .1617+03 | .9492+04 | .1220+01 |
| 300-21 | 30441. | .8103+00 | .2889+05 | .1175+00 | .3989+03 | .2341+05 | .2768+01 |
| 300-22 | 30441. | .8966+00 | .1104+05 | .1716-01 | .1687+03 | .9900+04 | .9559+00 |
| 300-24 | 42547. | .1783+01 | .1158+05 | .1888-01 | .3518+03 | .2065+05 | .5043+00 |
| 300-26 | 42547. | .1771+01 | .9128+04 | .1172-01 | .2754+03 | .1617+05 | .4000+00 |
| 300-27 | 42547. | .1847+01 | .4986+04 | .3498-02 | .1569+03 | .9208+04 | .2096+00 |
| 300-28 | 42547. | .1907+01 | .8763+04 | .1081-01 | .2847+03 | .1671+05 | .3566+00 |

****************************************************AVERAGED DATA POINTS*******

1318-88-14,CAP4,100F,8-14-7

| P (PSI) | V (CP) |
|---|---|
| .00000 | .61200+02 |
| .53590+04 | .14687+03 |
| .11093+05 | .30374+03 |
| .19488+05 | .93737+03 |
| .29296+05 | .41803+04 |
| .39597+05 | .27980+05 |

ALPHA STAR= .15200-03
ALPHA OT= .20875-03

1318-88-14,CAP4,210F,8-17-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .17400+02 |
| .53361+04 | .28568+02 |
| .11407+05 | .49184+02 |
| .23034+05 | .12856+03 |
| .33039+05 | .29189+03 |
| .41410+05 | .59553+03 |
| .47512+05 | .98279+03 |

ALPHA STAR= .89078-04
ALPHA OT= .98692-04

1318-88-14,CAP4,300F,8-17-71

| P (PSI) | V (CP) |
|---|---|
| .00000 | .82500+01 |
| .53552+04 | .14552+02 |
| .11178+05 | .23726+02 |
| .20126+05 | .45316+02 |
| .30393+05 | .83667+02 |
| .42547+05 | .18271+03 |

ALPHA STAR= .86929-04
ALPHA OT= .12535-03

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1318-88-14,CAP4,100F

| RUN | P3 | VISCP | NSHATE | KEC | DELTAP | TAUDYN | REYN |
|---|---|---|---|---|---|---|---|
| 100-1 | 11172. | .3436+01 | .3460+05 | .1141+00 | .9647+02 | .1168+06 | .5385+00 |
| 100-2 | 11134. | .2896+01 | .2250+06 | .4995+01 | .5360+03 | .6515+06 | .4229+01 |
| 100-3 | 11134. | .2739+01 | .2856+06 | .8014+01 | .6446+03 | .7806+06 | .5663+01 |
| 100-4 | 11134. | .2776+01 | .2459+06 | .5967+01 | .5638+03 | .6828+06 | .4821+01 |
| 100-5 | 11401. | .3078+01 | .3575+05 | .1261+00 | .9087+02 | .1101+06 | .6320+00 |
| 100-6 | 11325. | .2869+01 | .8250+05 | .6715+00 | .1968+03 | .2383+06 | .1554+01 |
| 100-7 | 11325. | .3124+01 | .2400+05 | .5683-01 | .6191+02 | .7497+05 | .4181+00 |
| 100-8 | 11248. | .3220+01 | .3475+05 | .1191+00 | .9238+02 | .1119+06 | .5874+00 |
| 100-9 | 11248. | .4875+01 | .4175+05 | .1726+00 | .1680+03 | .2035+06 | .4661+00 |
| 100-10 | 11134. | .3157+01 | .2200+05 | .4775-01 | .5734+02 | .6945+05 | .3793+00 |
| 100-11 | 11134. | .3065+01 | .4125+05 | .1679+00 | .1044+03 | .1264+06 | .7325+00 |
| 100-12 | 11134. | .3115+01 | .1975+05 | .3848-01 | .5080+02 | .6152+05 | .3451+00 |
| 100-13 | 11134. | .3342+01 | .5725+05 | .3234+00 | .1580+03 | .1913+06 | .9324+00 |
| 100-14 | 11134. | .3094+01 | .1050+05 | .1088-01 | .2682+02 | .3248+05 | .1847+00 |
| 100-15 | 11134. | .3101+01 | .1237+05 | .1511-01 | .3169+02 | .3838+05 | .2172+00 |
| 100-16 | 11172. | .3027+01 | .6936+04 | .4747-02 | .1734+02 | .2100+05 | .1247+00 |
| 100-17 | 11172. | .3297+01 | .1032+05 | .1052-01 | .2810+02 | .3403+05 | .1704+00 |
| 100-18 | 11153. | .3183+01 | .5710+04 | .3217-02 | .1501+02 | .1817+05 | .9765-01 |
| 100-19 | 11153. | .3001+01 | .2371+05 | .5546-01 | .5876+02 | .7117+05 | .4300+00 |
| 100-20 | 11153. | .3074+01 | .3823+05 | .1442+00 | .9706+02 | .1175+06 | .6768+00 |
| 100-21 | 11153. | .3072+01 | .4960+05 | .2428+00 | .1258+03 | .1524+06 | .8787+00 |
| 100-22 | 19332. | .9320+01 | .3612+05 | .1287+00 | .2780+03 | .3366+06 | .2109+00 |
| 100-23 | 19332. | .9214+01 | .9945+04 | .9758-02 | .7566+02 | .9163+05 | .5874-01 |
| 100-24 | 19332. | .9166+01 | .2336+05 | .5393-01 | .1769+03 | .2143+06 | .1388+00 |
| 100-25 | 19332. | .8942+01 | .3867+05 | .1475+00 | .2855+03 | .3458+06 | .2353+00 |
| 100-26 | 19332. | .8651+01 | .6791+05 | .4550+00 | .4851+03 | .5875+06 | .4272+00 |
| 100-27 | 19332. | .7905+01 | .1091+06 | .1174+01 | .7122+03 | .8625+06 | .7511+00 |
| 100-28 | 19332. | .1093+02 | .1608+05 | .2551-01 | .1452+03 | .1758+06 | .8004-01 |
| 100-29 | 19332. | .8641+01 | .4255+05 | .1786+00 | .3036+03 | .3677+06 | .2680+00 |
| 100-30 | 19332. | .9014+01 | .5640+05 | .3139+00 | .4198+03 | .5084+06 | .3406+00 |
| 100-31 | 19332. | .8003+01 | .8869+05 | .7761+00 | .5861+03 | .7098+06 | .6031+00 |
| 100-32 | 19309. | .9120+01 | .5172+04 | .2639-02 | .3898+02 | .4721+05 | .3084-01 |
| 100-33 | 19309. | .9563+01 | .9099+04 | .3168-02 | .7185+02 | .8701+05 | .5178-01 |
| 100-34 | 19309. | .7309+01 | .5551+04 | .3151-02 | .3410+02 | .4130+05 | .4208-01 |
| 100-35 | 19309. | .9595+01 | .1095+05 | .1163-01 | .8690+02 | .1042+06 | .6157-01 |
| 100-36 | 19309. | .8404+01 | .1699+04 | .2850-03 | .1179+02 | .1428+05 | .1101-01 |
| 100-37 | 19309. | .9039+01 | .5963+04 | .3508-02 | .4446+02 | .5385+05 | .3594-01 |
| 100-38 | 19309. | .8955+01 | .1491+04 | .2193-03 | .1102+02 | .1335+05 | .9060-02 |
| 100-39 | 19309. | .9357+01 | .7106+04 | .4982-02 | .5490+02 | .6649+05 | .4133-01 |

FLUID I

| TEMP. (DEG. F) | PRESS. (PSIG) | DENSITY (GM/CC) | VISCOSITY (POISE) | SHEAR STRESS (DYN/SQ.CM.) | SHEAR RATE (SEC-1) | CAPILLARY NUMBER |
|---|---|---|---|---|---|---|
| 100 | 51350 | 1.140 | 57.200 | 314900 | 5505 | 1 |
| 100 | 59970 | 1.160 | 124 | 170900 | 1380 | 1 |
| 100 | 59810 | 1.160 | 112 | 271300 | 2429 | 1 |
| 100 | 59730 | 1.160 | 108 | 361600 | 3348 | 1 |
| 100 | 59650 | 1.160 | 116 | 369600 | 3197 | 1 |
| 100 | 71370 | 1.180 | 371 | 206100 | 556 | 1 |
| 100 | 71370 | 1.180 | 368 | 259800 | 705 | 1 |
| 100 | 71200 | 1.180 | 375 | 520800 | 1389 | 1 |
| 100 | 71370 | 1.180 | 365 | 705000 | 1929 | 1 |
| 100 | 81430 | 1.200 | 992 | 298200 | 301 | 1 |
| 100 | 81270 | 1.200 | 949 | 380200 | 401 | 1 |
| 100 | 81430 | 1.200 | 965 | 418900 | 434 | 1 |
| 210 | 0 | .906 | .312 | 18100 | 58013 | 2 |
| 210 | 0 | .906 | .288 | 36200 | 125694 | 2 |
| 210 | 0 | .906 | .312 | 54000 | 173077 | 2 |
| 210 | 10430 | .976 | 1.020 | 2238 | 2194 | 4 |
| 210 | 10470 | .976 | 1.080 | 4004 | 3707 | 4 |
| 210 | 10470 | .976 | 1.050 | 4435 | 4224 | 4 |
| 210 | 10470 | .976 | 1.000 | 5169 | 5169 | 4 |
| 210 | 10550 | .976 | .980 | 10670 | 10888 | 4 |
| 210 | 10510 | .976 | .940 | 14320 | 15234 | 4 |
| 210 | 20290 | 1.020 | 2.130 | 3992 | 1874 | 4 |
| 210 | 20290 | 1.020 | 2.090 | 6105 | 2921 | 4 |
| 210 | 20290 | 1.020 | 2.000 | 17190 | 8595 | 4 |
| 210 | 20290 | 1.020 | 1.950 | 17600 | 9026 | 4 |
| 210 | 20350 | 1.020 | 1.870 | 19580 | 10471 | 4 |
| 210 | 51350 | 1.110 | 11.600 | 10070 | 868 | 4 |
| 210 | 51350 | 1.110 | 11.600 | 15350 | 1323 | 4 |
| 210 | 51350 | 1.110 | 11.700 | 18220 | 1557 | 4 |
| 210 | 51190 | 1.110 | 11.600 | 37510 | 3234 | 4 |
| 210 | 51190 | 1.110 | 11.800 | 38730 | 3282 | 4 |
| 210 | 51350 | 1.110 | 12.100 | 40190 | 3321 | 4 |
| 210 | 71600 | 1.160 | 33.400 | 6909 | 207 | 4 |
| 210 | 71430 | 1.160 | 32.400 | 11770 | 363 | 4 |
| 210 | 71430 | 1.160 | 30.700 | 12460 | 406 | 4 |
| 210 | 71430 | 1.160 | 32.500 | 21110 | 650 | 4 |

FLUID I

| TEMP. (DEG. F) | PRESS. (PSIG) | DENSITY (GM/CC) | VISCOSITY (POISE) | SHEAR STRESS (DYN/SQ.CM.) | SHEAR RATE (SEC-1) | CAPILLARY NUMBER |
|---|---|---|---|---|---|---|
| 100 | 0 | .957 | .792 | 0 | 0 | 100 |
| 210 | 0 | .906 | .306 | 0 | 0 | 200 |
| 300 | 0 | .864 | .157 | 0 | 0 | 150 |
| 100 | 0 | .957 | .832 | 6880 | 8269 | 3 |
| 100 | 0 | .957 | .814 | 14460 | 17789 | 2 |
| 100 | 0 | .957 | .800 | 43400 | 54250 | 2 |
| 100 | 0 | .957 | .837 | 49600 | 59259 | 2 |
| 100 | 10430 | 1.020 | 2.570 | 3056 | 1189 | 4 |
| 100 | 10390 | 1.020 | 2.520 | 4662 | 1850 | 4 |
| 100 | 10390 | 1.020 | 2.600 | 5704 | 2194 | 4 |
| 100 | 10300 | 1.020 | 2.520 | 7305 | 2899 | 4 |
| 100 | 10260 | 1.020 | 2.510 | 15480 | 6167 | 4 |
| 100 | 10220 | 1.020 | 2.380 | 16750 | 7038 | 4 |
| 100 | 10350 | 1.020 | 2.480 | 52130 | 21020 | 1 |
| 100 | 10350 | 1.020 | 2.370 | 96860 | 40869 | 1 |
| 100 | 10350 | 1.020 | 2.380 | 106500 | 44748 | 1 |
| 100 | 10350 | 1.020 | 2.280 | 118500 | 51974 | 1 |
| 100 | 20220 | 1.050 | 5.590 | 4005 | 716 | 4 |
| 100 | 20220 | 1.050 | 5.360 | 4365 | 814 | 4 |
| 100 | 20220 | 1.050 | 5.550 | 5330 | 960 | 4 |
| 100 | 20160 | 1.050 | 5.340 | 11240 | 2105 | 4 |
| 100 | 20090 | 1.050 | 5.410 | 15840 | 2928 | 4 |
| 100 | 20090 | 1.050 | 5.130 | 121300 | 23645 | 1 |
| 100 | 20090 | 1.050 | 5.180 | 20140 | 3888 | 1 |
| 100 | 20090 | 1.050 | 5.320 | 21890 | 4115 | 1 |
| 100 | 30370 | 1.080 | 12.000 | 114000 | 9500 | 1 |
| 100 | 30400 | 1.080 | 11.600 | 163500 | 14095 | 1 |
| 100 | 30240 | 1.080 | 10.600 | 281400 | 26547 | 1 |
| 100 | 30370 | 1.080 | 11.200 | 300100 | 26795 | 1 |
| 100 | 40420 | 1.110 | 26.400 | 5127 | 194 | 4 |
| 100 | 40420 | 1.110 | 25.500 | 9865 | 387 | 4 |
| 100 | 40420 | 1.110 | 25.800 | 12700 | 492 | 4 |
| 100 | 40420 | 1.110 | 26.200 | 16370 | 625 | 4 |
| 100 | 40590 | 1.110 | 26.200 | 27560 | 1052 | 4 |
| 100 | 40130 | 1.110 | 25.200 | 147200 | 5841 | 1 |
| 100 | 40130 | 1.110 | 23.500 | 152500 | 6489 | 1 |
| 100 | 40130 | 1.110 | 23.400 | 320000 | 13675 | 1 |
| 100 | 51350 | 1.140 | 58.300 | 166600 | 2858 | 1 |
| 100 | 51510 | 1.140 | 61.300 | 215900 | 3522 | 1 |
| 100 | 51350 | 1.140 | 59.000 | 265500 | 4500 | 1 |

FLUID J

| TEMP. (DEG. F) | PRESS. (PSIG) | DENSITY (GM/CC) | VISCOSITY (POISE) | SHEAR STRESS (DYN/SQ.CM.) | SHEAR RATE (SEC-1) | CAPILLARY NUMBER |
|---|---|---|---|---|---|---|
| 100 | 40290 | 1.380 | 180 | 442600 | 2459 | 1 |
| 100 | 40290 | 1.380 | 184 | 722300 | 3926 | 1 |
| 100 | 40130 | 1.380 | 176 | 107700 | 612 | 1 |
| 100 | 51190 | 1.410 | 720 | 267700 | 372 | 1 |
| 100 | 51350 | 1.410 | 722 | 310400 | 430 | 1 |
| 210 | 0 | 1.170 | .173 | 3440 | 19884 | 3 |
| 210 | 0 | 1.170 | .157 | 8600 | 54777 | 3 |
| 210 | 10390 | 1.260 | .686 | 4075 | 5940 | 4 |
| 210 | 10350 | 1.260 | .691 | 6040 | 8741 | 4 |
| 210 | 10430 | 1.260 | .675 | 10020 | 14844 | 4 |
| 210 | 10430 | 1.260 | .648 | 13100 | 20216 | 4 |
| 210 | 20730 | 1.290 | 1.840 | 4066 | 2210 | 4 |
| 210 | 20480 | 1.290 | 1.690 | 5866 | 3471 | 4 |
| 210 | 20800 | 1.290 | 1.720 | 12730 | 7401 | 4 |
| 210 | 20730 | 1.290 | 1.750 | 12900 | 7371 | 4 |
| 210 | 30240 | 1.320 | 3.560 | 9806 | 2754 | 4 |
| 210 | 30240 | 1.320 | 3.650 | 13250 | 3630 | 4 |
| 210 | 30270 | 1.320 | 3.640 | 15240 | 4187 | 4 |
| 210 | 40260 | 1.360 | 8.900 | 21940 | 2465 | 4 |
| 210 | 40260 | 1.360 | 8.820 | 22200 | 2517 | 4 |
| 210 | 40780 | 1.360 | 8.890 | 26100 | 2936 | 4 |
| 210 | 40940 | 1.360 | 8.860 | 29820 | 3366 | 4 |
| 210 | 40780 | 1.360 | 8.730 | 31070 | 3559 | 4 |
| 210 | 51350 | 1.390 | 18.200 | 11840 | 651 | 4 |
| 210 | 51350 | 1.390 | 18.100 | 12100 | 669 | 4 |
| 210 | 51680 | 1.390 | 18.100 | 14520 | 802 | 4 |
| 210 | 51510 | 1.390 | 19.000 | 24840 | 1307 | 4 |
| 210 | 51510 | 1.390 | 19.000 | 32740 | 1723 | 4 |
| 210 | 62120 | 1.410 | 37.000 | 11000 | 297 | 4 |
| 210 | 62120 | 1.410 | 38.100 | 12030 | 316 | 4 |
| 210 | 62120 | 1.410 | 36.900 | 27340 | 741 | 4 |

FLUID J

| TEMP. | PRESS. | DENSITY | VISCOSITY | SHEAR STRESS | SHEAR RATE | CAPILLARY NUMBER |
|---|---|---|---|---|---|---|
| (DEG. F) | (PSIG) | (GM/CC) | (POISE) | (DYN/SQ.CM.) | (SEC-1) | |
| 100 | 0 | 1.230 | .950 | 0 | 0 | 300 |
| 210 | 0 | 1.170 | .169 | 0 | 0 | 150 |
| 100 | 0 | 1.230 | .968 | 3440 | 3554 | 3 |
| 100 | 0 | 1.230 | .998 | 8600 | 8617 | 3 |
| 100 | 0 | 1.230 | 1.040 | 36200 | 34808 | 2 |
| 100 | 0 | 1.230 | 1.060 | 5400 | 5094 | 2 |
| 100 | 0 | 1.230 | 1.020 | 71800 | 70392 | 2 |
| 100 | 10360 | 1.290 | 4.460 | 5870 | 1316 | 4 |
| 100 | 10340 | 1.290 | 4.370 | 6600 | 1510 | 4 |
| 100 | 10160 | 1.290 | 4.290 | 9604 | 2239 | 4 |
| 100 | 10160 | 1.290 | 4.220 | 9844 | 2333 | 4 |
| 100 | 10320 | 1.290 | 4.100 | 9952 | 2427 | 4 |
| 100 | 9962 | 1.290 | 4.100 | 13730 | 3349 | 4 |
| 100 | 10120 | 1.290 | 4.270 | 19020 | 4454 | 4 |
| 100 | 10430 | 1.290 | 4.630 | 38560 | 8328 | 1 |
| 100 | 10470 | 1.290 | 4.510 | 53360 | 11831 | 1 |
| 100 | 10470 | 1.290 | 4.430 | 86300 | 19481 | 1 |
| 100 | 10470 | 1.290 | 4.220 | 100500 | 23815 | 1 |
| 100 | 20080 | 1.330 | 16.500 | 4524 | 274 | 4 |
| 100 | 20080 | 1.330 | 16.700 | 5700 | 341 | 4 |
| 100 | 20170 | 1.330 | 16.400 | 27350 | 1668 | 4 |
| 100 | 20210 | 1.330 | 17.200 | 36760 | 2137 | 4 |
| 100 | 20220 | 1.330 | 15.200 | 54750 | 3602 | 1 |
| 100 | 20280 | 1.330 | 16.000 | 86800 | 5425 | 1 |
| 100 | 20220 | 1.330 | 15.400 | 117100 | 7604 | 1 |
| 100 | 19710 | 1.330 | 15.400 | 152000 | 9870 | 1 |
| 100 | 20410 | 1.330 | 14.500 | 253900 | 17510 | 1 |
| 100 | 20380 | 1.330 | 14.400 | 316500 | 21979 | 1 |
| 100 | 20350 | 1.330 | 14.100 | 400000 | 28369 | 1 |
| 100 | 30010 | 1.360 | 53.800 | 10170 | 189 | 4 |
| 100 | 30070 | 1.360 | 52.600 | 13540 | 257 | 4 |
| 100 | 29940 | 1.360 | 51.700 | 17080 | 330 | 4 |
| 100 | 29940 | 1.360 | 52.600 | 18770 | 357 | 4 |
| 100 | 30560 | 1.360 | 55.700 | 116000 | 2083 | 1 |
| 100 | 30500 | 1.360 | 50.400 | 153900 | 3054 | 1 |
| 100 | 30460 | 1.360 | 49.300 | 242000 | 4909 | 1 |
| 100 | 30430 | 1.360 | 52.800 | 354800 | 6720 | 1 |
| 100 | 40290 | 1.380 | 182 | 314300 | 1727 | 1 |
| 100 | 40130 | 1.380 | 182 | 364900 | 2005 | 1 |
| 100 | 40210 | 1.380 | 178 | 39600 | 222 | 1 |

QXQT
MAP 0017-12/28-12:33
START=011426, PROG SIZE(I/D)=4758/2245

FLUID DC-200-500 lot AA 8250

| TEMP. (DEG.F) | PRESS. (PSIG) | DENSITY (GM/CC) | VISCOSITY (POISE) | SHEAR STRESS (DYNE/SQ.CM.) | SHEAR RATE (1/SEC.) | CAP. NO. |
|---|---|---|---|---|---|---|
| 75 | 5017.8 | .971 | 10.298 | 10743.5 | 1043.3 | 4 |
| 75 | 11572.7 | .971 | 24.643 | 24392.4 | 989.8 | 4 |
| 75 | 11820.5 | .971 | 23.860 | 33158.5 | 1389.7 | 4 |
| 75 | 11820.5 | .971 | 23.935 | 35097.8 | 1466.4 | 4 |
| 75 | 11820.5 | .971 | 23.184 | 25397.0 | 1095.5 | 4 |
| 75 | 19899.8 | .971 | 46.979 | 34819.3 | 741.2 | 4 |
| 75 | 19701.5 | .971 | 47.450 | 16253.0 | 342.5 | 4 |
| 75 | 19701.5 | .971 | 47.263 | 25346.6 | 536.3 | 4 |
| 75 | 19701.5 | .971 | 46.901 | 12689.0 | 270.6 | 4 |
| 75 | 19701.5 | .971 | 47.417 | 24136.4 | 509.0 | 4 |
| 75 | 29188.0 | .971 | 103.548 | 25599.3 | 247.2 | 4 |
| 75 | 29188.0 | .971 | 98.264 | 32161.7 | 327.3 | 4 |
| 75 | 29188.0 | .971 | 99.603 | 22542.2 | 226.3 | 4 |
| 75 | 29188.0 | .971 | 91.793 | 20834.0 | 227.0 | 4 |
| 75 | 29188.0 | .971 | 105.014 | 27685.1 | 263.6 | 4 |
| 75 | 29188.0 | .971 | 97.684 | 21299.4 | 218.0 | 4 |
| 75 | 40403.9 | .971 | 217.441 | 26041.6 | 119.8 | 4 |
| 75 | 40403.9 | .971 | 188.388 | 27995.3 | 148.6 | 4 |
| 75 | 40403.9 | .971 | 193.360 | 29942.8 | 154.9 | 4 |
| 75 | 40403.9 | .971 | 197.524 | 26294.1 | 133.1 | 4 |
| 75 | 40403.9 | .971 | 197.524 | 26294.1 | 133.1 | 4 |

@XQT
MAP 0017-12/28-12:33
START=011426, PROG SIZE(I/D)=4758/2245
FLUID DC-200-500 lot AA 8250

| TEMP. (DEG.F) | PRESS. (PSIG) | DENSITY (GM/CC) | VISCOSITY (POISE) | SHEAR STRESS (DYNE/SQ.CM.) | SHEAR RATE (1/SEC.) | CAP. NO. |
|---|---|---|---|---|---|---|
| 210 | 5073.3 | .906 | 3.322 | 12768.1 | 3843.7 | 4 |
| 210 | 5073.3 | .906 | 3.354 | 22558.6 | 6726.5 | 4 |
| 210 | 11671.8 | .906 | 6.677 | 18598.6 | 2785.6 | 4 |
| 210 | 11671.8 | .906 | 7.004 | 19169.9 | 2736.8 | 4 |
| 210 | 11671.8 | .906 | 6.669 | 21909.1 | 3285.2 | 4 |
| 210 | 11671.8 | .906 | 6.906 | 13948.1 | 2019.8 | 4 |
| 210 | 11671.8 | .906 | 6.707 | 14639.1 | 2182.6 | 4 |
| 210 | 11671.8 | .906 | 6.715 | 12693.6 | 1890.5 | 4 |
| 210 | 20029.2 | .906 | 11.331 | 22531.9 | 1988.5 | 4 |
| 210 | 20029.2 | .906 | 11.991 | 32833.0 | 2738.2 | 4 |
| 210 | 20029.2 | .906 | 11.765 | 20327.0 | 1727.7 | 4 |
| 210 | 20029.2 | .906 | 10.208 | 11310.1 | 1108.0 | 4 |
| 210 | 20029.2 | .906 | 11.806 | 16900.0 | 1431.4 | 4 |
| 210 | 20029.2 | .906 | 11.722 | 19102.4 | 1629.6 | 4 |
| 210 | 29339.5 | .906 | 20.385 | 23288.3 | 1142.4 | 4 |
| 210 | 29339.5 | .906 | 20.149 | 20074.8 | 996.3 | 4 |
| 210 | 29339.5 | .906 | 19.910 | 20856.5 | 1047.5 | 4 |
| 210 | 29491.0 | .906 | 20.222 | 15181.5 | 750.7 | 4 |
| 210 | 29491.0 | .906 | 19.683 | 21764.6 | 1105.7 | 4 |
| 210 | 40064.7 | .906 | 32.544 | 22159.5 | 680.9 | 4 |
| 210 | 40064.7 | .906 | 30.035 | 21954.3 | 731.0 | 4 |
| 210 | 40064.7 | .906 | 31.420 | 22396.2 | 712.8 | 4 |
| 210 | 40064.7 | .906 | 31.807 | 22424.5 | 705.0 | 4 |
| 210 | 40064.7 | .906 | 32.440 | 22655.2 | 698.4 | 4 |